60p

YOUR COMPUTER

JANUARY 1982

Vol.2 No.1

We look inside the BBC micro

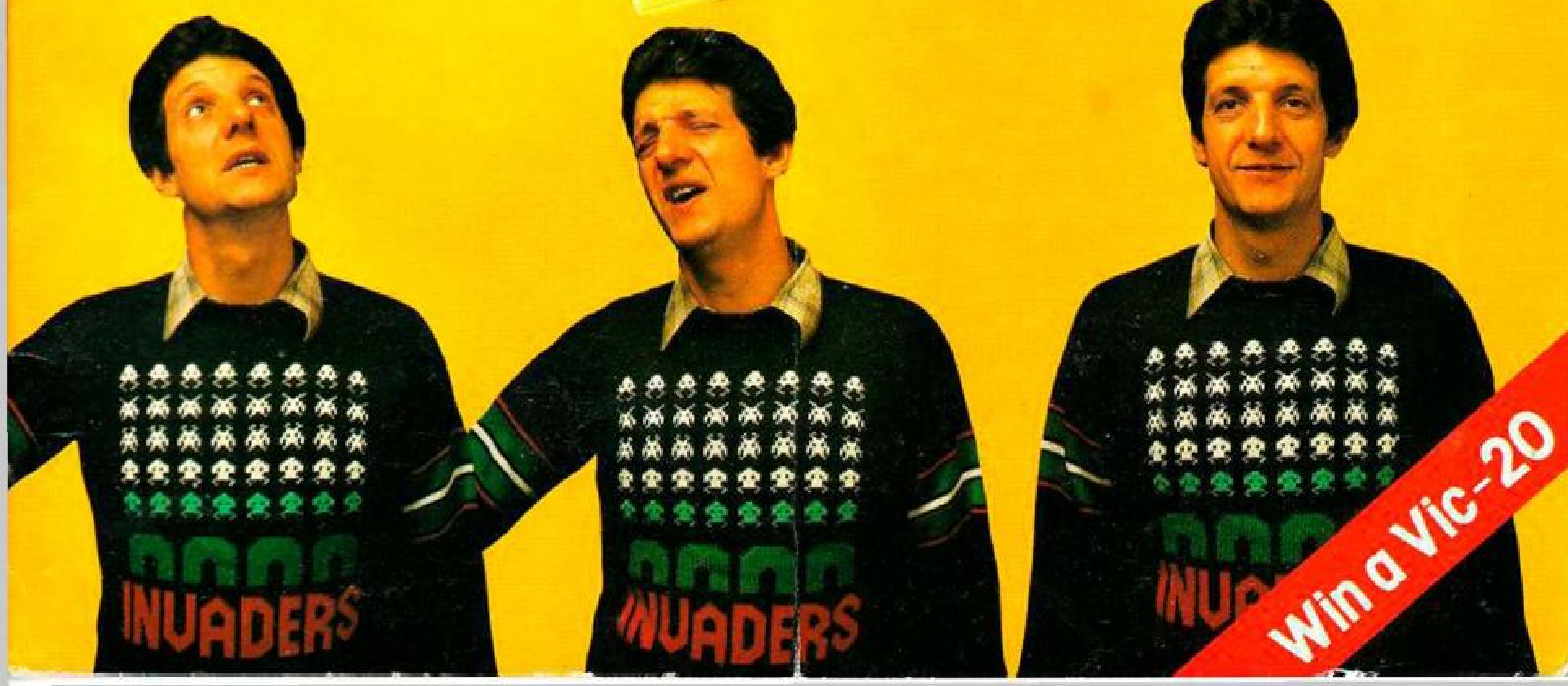


Review: Atom word processor

New chess machines

Sinclairs in schools

Fast ZX-81 graphics



Win a Vic-20



ingenious!

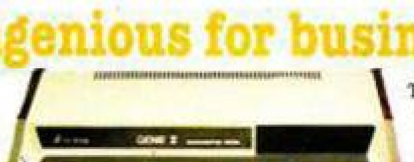
...that's the only word to really describe the superb Genie microcomputer system, the home computer which is compatible with the TRS 80, and ideal for all micro-enthusiasts, especially the committed hobbyist.

Genie has now been upgraded to Genie I, incorporating all of the original, excellent features, but with the addition of:

- Extended BASIC, including RENUMBER and SCREEN PRINT.
- Full upper and lower case, flashing cursor and auto-repeat on all keys.
- An internal SOUND UNIT to add a new dimension to your own programs.
- A MACHINE LANGUAGE MONITOR, with Display, modify, enter and execute (with break points) facilities.

Genie I has all of this, plus the built-in cassette deck, 16K RAM, 12k ROM with BASIC interpreter, full-size keyboard, an extremely wide range of new and updated peripherals, and literally 1000's of pre-recorded programmes available. Yet, almost unbelievably, the price of Genie I is even lower than that of the original Genie.

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YOUR COMPUTER

Cover photographs of Chris Serle and the BBC Microcomputer by Stephen Oliver. Our thanks go to Stone & Son, Upper Richmond Road, London SW15, for the loan of the Space Invaders pullover.

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EDITORIAL

1982 IS INFORMATION Technology Year. During the year the Government hopes to ram home the message to the British public that if we want to see our living standards rise or, less optimistically, if we want to slow up the decline, we will all have to embrace new technology in our business and private lives. In an interview on page 24 Kenneth Baker, the Government Minister responsible for IT '82, sets out some of his plans. Most of them, so far as personal computing goes, seem to be extensions of existing schemes. They include the Government putting up half the cost of buying computers for schools and giving away 100 computers in a schools essay competition.

Although we live under a Government which supposedly abhors the idea of intervening in industry, it defends the principle of "pump-priming" — injecting a little money to start the ball rolling. However, now that more than a quarter of a million people in Britain own or use a personal computer, and given that the rate of growth of the market is accelerating, it strikes *Your Computer* that the Government has come into the act a little late.

Its offer to help schools buy personal computers looks irrelevant compared with the massive orders taken by Sinclair and the BBC each month. Although we are sure that a number of science teachers would disagree, it is possible that the schools would prefer to have the extra money to buy more textbooks.

Whatever the Government does now is hardly likely to change significantly the way the market develops. Its momentum is such that the most the Government can hope for is a small slice of the action and, on past record, will spend far more money in achieving it than is really necessary.

There are students of politics who would argue that one of the primary roles of a government is to establish the ground rules which the rest of us follow in our business. In many ways *Your Computer* would rather see the Government resolve some of the legal confusions surrounding computing and let us carry on with the business of buying, selling, making and using personal computers. If the Government needs any guidance on some of the areas which need legal clarification, *Your Computer* suggests it starts, after many years of pushing it down its list of priorities, by tackling the thorny question of software copyright.

If any of you ever try to make money from selling some of the games or educational programs you have written only to find some unscrupulous software company making and selling illicit copies, you soon see the need for copyright reform. It is a difficult question, as Kenneth Baker rightly says, but it is exactly the kind of question we elect governments to answer. ■

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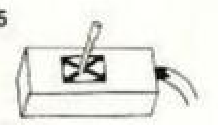


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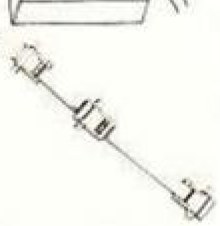
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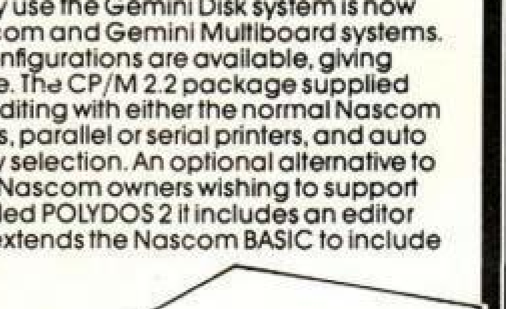
With hundreds in daily use the Gemini Disk system is now the standard for Nascom and Gemini Multiboard systems. Single or twin drive configurations are available, giving 350K storage per drive. The CP/M 2.2 package supplied supports on-screen editing with either the normal Nascom or Gemini IVC screens, parallel or serial printers, and auto single-double density selection. An optional alternative to CP/M is available for Nascom owners wishing to support existing software. Called POLYDOS 2 it includes an editor and assembler and extends the Nascom BASIC to include disk commands.

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RENUMBER AGAIN

I was pleased to see my ZX-81 renumber program published in the November 1981 Software File. The program will work in a 1K machine, but if run on a 16K ZX-81, it will crash.

The problem lies in the machine-code routine — the 15th byte, to be exact. This byte should be 0 and not 118 as shown. This can be easily rectified by changing M(15) to 0. I hope this did not cause too much confusion with any readers who own a 16K machine.

James Tyler, Portsmouth.

GIRLS DO COMPUTE

The November 1981 issue was the first copy of *Your Computer* I have seen. First impressions were very favourable. Then I read the editorial, "Why don't girls compute?". The first three paragraphs may be fact, the final two which contain sentences like: "The other culprits are the schools" and "Let's tell the teachers to think again" nearly made me blow a fuse. When did the writer last spend time in a school and where does he find these fantasies he presents as facts?

Visit an ordinary neighbourhood school such as the secondary school where I teach. For at least the last five years, all pupils in their first three years here have done everything. They must have this opportunity by law. So, boys and girls cook, sew, do wood and metal work, technical drawing, all the sciences, at least one foreign language and a substantial number have a taste of practical electronics plus the usual mathematics, English and religious education.

When the moment arrives to choose subjects to study for a further two years to O or CSE level, the old separation of the pupils, of which the editorial complains, reappears.

Very few girls opt to take technical subjects. Only one girl in 10 years has followed our O-level technology course. The proportions in the sciences are not so bad, though the balance is in favour of the boys.

The root cause of this phenomenom is cultural — it is part of the underlying structure of society which determines what boys and girls do. Nothing is going to alter that overnight — not editorials, nor teachers driving themselves frantic about able girls not developing their obvious scientific and technical ability, nor even the substantial financial discrimination in favour of girls taking technical subjects in further and higher education as promoted by the Engineering Industry Training Board.

Interestingly, a good many boys choose to do O-level home economics — but then, that is culturally acceptable as men have always been cooks and chefs, and good ones, too. We find girls wanting to do the so-called boys' subjects but, to our despair, they cannot withstand pressure from parents and peers to do otherwise.

It takes a good deal of courage and drive to break out of the cultural mould. However, educational researchers have found that in all-girls' schools the problem is of minor significance and some very good scientific and technical work is done in these schools.

As far as computing goes, for a number of years we have run an O-level computer studies course with a terminal linked to Hatfield Polytechnic and now additionally with a 380-Z bought with money raised by all the pupils. Of the 120 pupils currently on the course, 63 are girls. The teacher is a woman — and so was her predecessor.

So, please do not attack teachers and schools. Find out what we manage to achieve despite seven years of educational spending cuts. Support us in the fight against cuts proposed for 1982/83 which will make anything in the past look insignificant.

P L Patient, Heronswood School, Welwyn Garden City, Hertfordshire.

LOADING TROUBLE

In your October edition D Somerville has a query regarding the use of a cassette recorder with a ZX-81. I experienced similar problems, on a borrowed computer, until I tested the interconnecting leads supplied by Sinclair.

I found that the yellow-marker sleeves fitted at each end were not on the same lead, so that the microphone socket on the ZX-81 was connected to the ear socket on the recorder and vice versa. Rectifying this fault made a considerable difference.

However, I still found difficulty in loading from one recorder using a cassette which had had a program saved on another. The solution seemed to be to Load from the original recorder and then Save on the new one. Reliable results have been obtained since then.

J D Cheal, Eastleigh, Hampshire.

MANUAL MISTAKES

I received my Sinclair printer this week — two months after my order — and have been very happy with its performance. Potential owners of the printer may be interested to know that a new transformer is supplied, paper refills cost £12 for a five-pack and the printer manual contains at least three mistakes.

A high-resolution graph can be plotted in a 9cm. square area using 256 by 256 points, these points are stored in an 8K character array and the method is adequately described in the printer manual. I was unable to plot the last few rows of the array before I noticed an error in the manual: line 9989 on pages 14 and 16 should read:

```
9989 For I=0 TO 256 step 8
```

A worked example is supplied for a sine and cosine graph. However there is a discrepancy between the description on page 6 and its graph on page 17, the straight line plotted should have been a cosine curve. Line 110 on page 16 should read:

```
110 Let Y = 128 + 120 * COS
    (X/128*PI)
```

I would suggest a 16K pack be bought before a printer if the printer is to be used to its full potential.

Paul Cook, Woking, Surrey.

VISUAL HANDICAP

The letter in Response Frame November 1981, from registered blind enthusiast F A Norton interested me very much. I had the same problem about 18 months ago — I am limited to some vision in one eye.

The computer I finally chose was the TRS-80, mainly because of its ability to display either 32 or 64 characters per line — an invaluable facility when writing and listing programs. Using a portable TV was not so successful, as there is an inevitable blurring of text and graphics, so I recommend investing in a proper VDU.

Perhaps others with vision problems would like to contact me; it might be possible to exchange ideas and tips. Write to me at: Flat 5, 24 Windlesham Gardens, Brighton, East Sussex BN1 3AJ.

P V Bamfield Brighton, East Sussex.

ATOM SOFTWARE

I have been reading Eric Deeson's article in the November issue of *Your Computer*, concerning Atom software. I am amazed at the huge range available for the Atom: it seems that programs are becoming better and cheaper all the time.

I sympathise with him for the problems he has had in loading programs. My advice to people who buy cassettes from software companies is to save the programs on your own tape as soon as you have loaded them and checked that they are working properly. This has several advantages:

- If your cassette is a good-quality one, you should not have nearly as much trouble in loading.
- You can record a program at the desired volume and tone levels.
- Loading is generally quicker for long machine-code programs from your own cassette than it is for the software cassette.

Though I admit that the description of the editing system in the Acorn manual is not very good, all becomes clear when using the keyboard. The essential thing is that the Edit keys must be used with the Copy key — pages 132-133.

P Gibbon, Norwich.

COURTEOUS CLIVE

After the modifications suggested by P R Ainsworth in Software File November 1981 I can now enter into my 16K RAM programs without breaking into a sweat after line 200. Sinclair Research has been both courteous and prompt in sending me a replacement RAM after I sent the original back.

If anyone is suffering from eye twitch as a result of the hours spent staring into a black-and-white TV monitor, he might care to try placing a small sheet of smoky transparent Perspex in front of it.

Raymond Akhurst, Forres, Scotland.

ZX REPEAT-UNTIL

Much has been written in recent months about the convenience and simplicity of the Pascal-like statements Repeat and Until, which have been incorporated in some more recent versions of Basic. I have found my ZX-81 has a feature which allows Repeat-Until to be simulated relatively simply.

The secret is that in ZX-81 Basic, the expression-evaluator routine takes the highest priority, so that the statement Goto (expression) is valid, provided the evaluation of the said expression returns an integer value.

Thus the loop

```
      10 REPEAT
     {12
loop {14
     {16
     {18
      20 UNTIL (condition)
```

may be implemented in ZX-81 Basic by

```
12 (beginning of loop)
14
16
18
20 GO TO (condition)*9 + 12
```

If the condition is false, the program will return to line (0)*9+12 — i.e., 12 — and if the condition is true, the program will proceed to line (1)*9+12 i.e., 21 — to jump out of the loop.

N Haughton, Wokingham, Berkshire.

Sharp's sound of music

A NEW TYPE of microcomputer software has emerged — music programs for home computers. Maris and Tresham have written a series of music programs for the Sharp MZ-80K microcomputer which has an integral loudspeaker. The writers maintain that among the collection there is music for all the family.

For the younger computer user there is Rhymes, a selection of 20 favourite nursery ryhmes with both words and music. The program is easy to operate and can even be run by very small children.

Melody is a musical quiz game for up to six contestants. A fragment of a popular tune is played and the title must be guessed. There are three levels of play and a total of 3,500 possible combinations. All three programs are available from Newbear Computing Stores and Sharp dealers. Further details from Maris and Tresham, 19 Pytchley Way, Brixworth, Northampton

Hearing is believing

TELESOUND 82 WILL find a receptive audience among *Your Computer* readers who have no integral sound-generation facilities on their microcomputers. The device is suitable for most of the more popular home computers and fits them in a manner which enables the generated sound effects to be heard from the television loudspeaker.

Sound is modulted and then fed to the UHF video modulator, where the combined signal is decoded by the television set so that both the sound and vision appear from the same source.

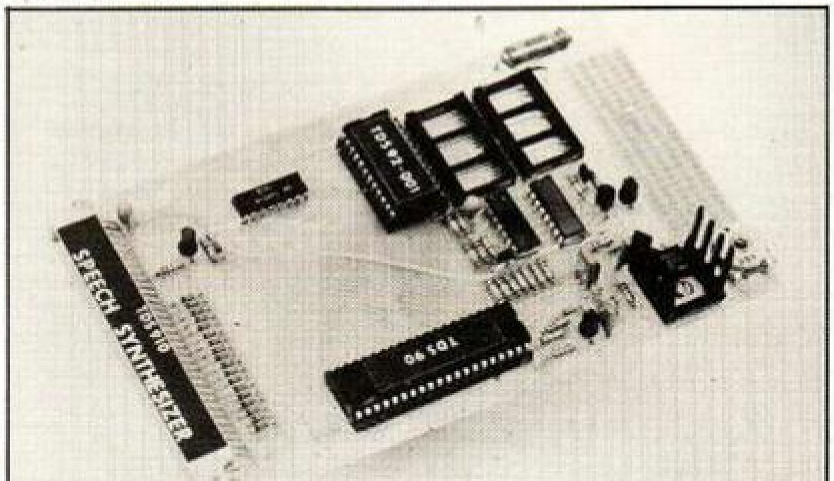
Sound effects are generated by programming the microcomputer's cassette output. The desired effect is controlled entirely by software. If the computer system already has a sound effects board then the Telesound unit connects to the audio output eliminating the need for amplifier and loudspeaker. Help in programming can be given to computer users, hoping to use the unit in conjuction with the ZX-80, ZX-81, Atom, Microtan, TRS-80, Apple and Nascom microcomputers.

Telesound 82 is supplied ready-built and tested. Four connections are required, one to the audio source — in most cases the cassette output — one to the UHF video-modulator input. These connections are made by leads with alligator clips eliminating the need for soldering.

The two other connections are to the power supply. Details are supplied to enable the unit to be fitted either remotely or within the computer case. This is possible because of the minute size of the device — about the same as an Astec UHF video modulator.

The Telesound 82 unit costs £9.95 and is available from Compusound (U.K.) Limited, 32, Langley Close, Redditch, Worcestershire.

How TDS-934 delivers speech



THE EUROCARD version of Triangle Digital Services speech synthesiser forms the basis of a series of products which enable the computer user to create speech. The Eurocard 910 retails at £97.06. However, the TDS-934 chip set costs only £39 and contains the essentials for a speech-generation system using Triangle's own Instant Speech method.

The TDS-934 set comprises a speech synthesiser TDS-90 and speech memory TDS-92-001, together with four normal integrated circuits which provide the voltage regulation and the requisite analogue filtering.

The device does not necessarily require a microprocessor to operate, though it helps. Simple switch closures can generate 16 different phrases.

For more details contact Triangle Digital Services Ltd, 23 Campus Road, London E17 8PG. Telephone: 01-520 0442.

The Computer Fair caters for all

THE FIRST Computer Fair is to be held this spring at Earls Court exhibition centre. The Fair, jointly sponsored by *Your Computer* and *Practical Computing,* will concentrate on three areas: home computing, small-business computing and personal computing. The Fair will run from Friday, April 23 to Sunday, April 25.

The Computer Fair will literally have something for everybody, from games on microcomputers — space invaders *et al.* — to systems for the small business, and everything in between. The U.K. final of the Euro-Micromouse competition will be held at the show. It is a competition where little robots or micromice hunt for the centre of mazes. The winner is the robot mouse which reaches the centre of the maze in the fastest time.

Serious computer users will be catered for — this will give anyone who needs one an excuse to attend — and you may leave having bought yourself a brand-new office system. Computers are making inroads into other areas of activity; at the Computer Fair you will be able to see every facet of microcomputers in the modern world

The show is being organised by IPC exhibitions, which already runs Compec, and it occurs at a seminal point in the history of microcomputers — not only is 1982 the Government's Information Technology Year, it is the year of the BBC microcomputer series and of an explosion in the sales of microcomputers at the bottom end of the price scale.

British Telecom offers £1,000 prize for best Sinclair Prestel adaptor

BRITISH TELECOM has put up a £1,000 prize for the designer of the best Prestel adaptor for the Sinclair ZX-81. The object is to stimulate the growth of telesoftware — programs sent via Prestel.

Ideally the ZX-81 will load executable code from a Prestel frame direct into the ROM of the ZX-81, ready to run. The adaptor, which will require hardware construction as well as software, should:

- Comply with British Telecom requirements for attachment.
- Be capable of eventual production, and of future development.
- Permit the use of the Council for Educational Technology (CET) telesoftware format.
- Be "in the spirit of the ZX-81".

In practical terms this last proposition means that the adaptor should combine low price, elegant design and robustness. The entries will be judged by Dr Ederyn Williams of Prestel and it is hoped that Clive Sinclair will take an active interest. Entries should be at Prestel HQ by March 14, and the best ones will be shown at the Computer Fair, April 23-25.

Would-be constructors will need to invest in a copy of the Prestel technical specification, price £10. A working prototype capable of being modified so as to receive approval for attachment to the telephone network must be submitted to Prestel, but the design will remain the property of the designer — giving the added incentive of run-on profits.

Further details, with specification and entry forms, are available from Tony Sweet, Prestel HQ, Telephone House, Temple Avenue, London EC4Y 0HL.



This ZX-81 plinth, moulded in a matt-black plastic, is designed to raise and tilt the television monitor to minimise eye strain. The unit will hold the ZX-81 microcomputer, the 16K RAM pack and hides the wiring and power supply. The ZX-81 plinth costs £15, a built-in power switch costs a further £3, postage is £1.50. All prices include VAT. Contact Peter Furlong Products, 125 Catford Hill, London SE6 4PR. Telephone: 01-690 7799. Credit Card orders will be accepted by Telephone.

Expand control possibilities

THE P-PACK is a unit which plugs into the rear of the Sinclair ZX-81 microcomputer. Not only does the unit add an extra 5K of user memory, expanding the possibilities of the computer, but it also adds an eight-bit input port and an eight-bit output port. That means the micro can be used in applications.

DCP, the manufacturer, claims that the unit will control anything from a train-set to a production line. The entire package is contained in a black plastic case which matches the case of the ZX-81. The pack is provided fully assembled, readily tested and guaranteed. Retail price of the P-Pack is £37.95 inclusive and the unit can be purchased by mail order directly from DCP.

DCP is a new electronics company which aims to develop and design a range of products which initially will be add-ons for other manufacturers' products. The address is DCP Microdevelopments, 2 Station Close, Lingwood, Norwich NR13 4AX. Telephone: Norwich (0603) 712482.

Bug-free machine code

MACHINE-CODE programming on the Sinclair ZX-81 microcomputer is no easy task but now a debugging program provides the answer. The classic problems are how to store machine code, where to store it, and the saving and loading cassette operations. To remove these obstacles, a fast machine-code debug program has been developed by Picturesque. The software will run on an expanded ZX-81 and is called ZX-MC.

It has a number of facilities, but the most useful are the ability to save a named file to cassette from any RAM area upwards of 4E00H at twice the speed of a Basic save routine.

Of course, the converse function exists, the loading of the file back to the correct area of RAM.

Other facilities include the ability to inspect memory locations and enter hexadecimal op-codes, the ability to inspect and manipulate the Z-80 CPU registers, and the execution of routines from a specified address. Breakpoints can be entered to return control to ZX-MC, and a return from a breakpoint will give no ill effects. It is possible to insert or delete up to 255 bytes in a routine, without destroying the subsequent code.

The ZX-MC program resides in about 2.5K of RAM above the area occupied by Basic. This means that the display RAM — D file — does not move.

ZX-MC is available on cassette together with full documentation and costs £6.50.

Other programs from Picturesque are a Life program and a suite of machine-code routines. Picturesque, 6 Corkscrew Hill, West Wickham, Kent. Telephone: 01-777 0372.

Recalled Vic transformers

A "TECHNICAL fault" lies behind the Commodore moves to recall all transformers distributed with the initial batch of Vic-20 microcomputers. According to a Commodore spokesman: "One of two are not up to scratch".

The 4,000 Vic users affected have all been contacted by Commodore. The computer itself is not at risk as the transformer is a separate unit.

Another problem of concern to potential Vic users is slow delivery. Among the many explanations circulating to account for it is the mysterious loss of a lorry-load of Video Interface Chips en route to the West German factory.

Software and hardware harmonise for Tandy



TRS-80 USERS can now enter the world of stereo-music synthesis with Orchestra-85, a fascinating new package which comprises both software and hardware. Music and percussive sounds can be synthesised with this new device from Software Affair — a Californian company which specialises in add-ons for home computers. The package should be available at dealers in the U.K. from the spring.

The stereo separation is by instrument. This means that, for example, trumpet and oboe can play through the left channel while clarinet and organ can play through the right-hand one. You can create a wide range of percussive sounds and special effects at the same time or, if required, separately.

The software provided enables the creation of five-part harmonies. Clock speeds are, of course, important in the creation of music; the Orchestra-85 can cope with 2.66. 3.54, and 4MHz speeds.

Music can be entered as sheet music into the system's full-screen text editor, or loaded directly from files. The unit is supplied together with software on tape, sample music files, and an instruction manual.

Orchestra-85 plugs into any 16K TRS-80 level II keyboard without invalidating the microcomputer's warranty, and without the need for a separate power supply. The high-level stereo output may be connected to the aux/tape tuner inputs of any stereo amplifier.

New ZX-81 program launches

SOFTWARE FOR the ZX-81 seems to be multiplying daily now — it is hardly surprising considering the large number of these computers in circulation. Artic Computing recently launched a ZX-81 chess program and has since then upgraded it, making it both faster and stonger. New features include random opening moves, a recommendation of the best move for the player together with an extra level which enables lightning chess.

The chess program has a club rating of around 110 at level three, which takes one minute per move. The program retails at £15. If anyone has purchased the original program it will be updated for £5.

For games players who find chess is not their cup of tea, Artic has a version of the popular Adventure game. Called Adventure B, the new game has 57 locations and 60 objects. Data can be saved to tape enabling the player to return to a game at a later date. Adventure B costs £9, and a third adventure game will shortly be available.

Not everyone uses the ZX-81 just for games — to satisfy the needs of these users Artic Computing has ZXbug. This useful item of software has been rewritten and many functions have been added including cassette routines and a disassembler. The program retails at £9. Artic Computing can be found at 396 James Reckitt Avenue, Hull, North Humberside.

Starting your own business

IF YOU HAVE ever thought of starting your own business and you own a ZX-81, then the package from S Electronics may be of interest to you. The program moves into its own in those situations where a product is manufactured or bought and sold in batches and provides the information required to build up the venture as fast as possible without overtrading.

Included on the cassette is a game varient of the program; both programs fit in the unexpanded 1K version of the computer. S. Electronics is located at 1 Orchard Road, Hayling Island, Hampshire. Telephone: 07016-5191.

The 32K memory-extension board for the Acorn Atom is part of a range of memory-extension boards which fit inside the Atom case or are provided with a standard connector. The Atom board is available in both 16 and 32K versions, extending the machines memory to either 28K or 38K. The on-board decoding allows the added memory to be located at any 1K address boundary onward. The 16K Atom extension costs £59 and the 32K version, £74. Versions with DIN connector 41612 cost £62 for the 16K version and £76.50 for the 32K. All the boards are available from Timedata Limited, 57 Swallowdale, Basildon, Essex SS15 5BZ. Telephone: 0268-23234.



ZX80/81 HARDWARE/SOFTWARE

2K RAM PACK	£15.95
4K RAM PACK	£22.95
16K KIT	£32.95
16K ROM PACK	£42.95

DEFLEX
LIFE & 3D/3D £5.95
on one cassette

ZX KEYBOARD	£27.95
16K SOFTWARE CASSETTES	from £3.95
4K GRAPHIC ROM	£29.95

ZX KEYBOARD



One of the biggest problems with the Sinclair computer is that the keyboard is rather a finger ache. This has now been solved with the aid of a full size keyboard which is suitable for the 80/81. This is not a revamp of a commercially available keyboard; it has been designed for the Sinclair. This makes it unique. Our keyboard measures 10.25 inches by 3.5 inches and is of course fitted with push type keys, which makes programming a lot more interesting and very much quicker. Because the keys have a positive feel you don't have to keep looking up to the screen and this helps to stop eye strain. The lay-out is the same as your touch sensitive one in that it has 40 buttons; we have allowed facilities for 4 extra buttons to be added. So you could add an on/off switch or a reset etc. We use a two part type of key top. This enables us to have all the normal functions, graphics, letters etc on the keys. They are then fitted under the clear part of the top so they cannot be rubbed or wear off. This is the only reasonable way to get ZX81's 5 functions on the tops. The keyboard is a completely free-standing item. The keys are mounted at an angle so the keyboard has a sloping front. It has rubber feet stuck to its base so that it does not slide around. The keyboard is connected to your computer by 13 coloured ribbon.

MEMORY

2-4K RAM PACK. The 2-4K RAM expansions both use static RAM memory chips, they also both work with the original 1K of RAM inside the computer. This means that the 2K=3K and the 4K=5K. They both use the same PCB so if you bought the 2K you could increase it to 4K at a later date. Both the memory expansions plug into the port at the rear of the computer. All dK memory expansions work with the printer, and need NO additional power supply.

THE ABOVE RAMS NEED NO EXTRA POWER AND WORK FROM YOUR SINCLAIR POWER SUPPLY.

16K RAM PACK. The 16K RAM uses 4116 dynamic RAM chips and is similar to the Sinclair RAM pack. We use the dynamic as they are much denser than static RAM and occupy less space; they are also much cheaper than the equivalent product using the static RAM. With our 16K RAM you will also receive a new power supply — it is a direct replacement for your Sinclair supply and is used in the same way, the old supply no longer being used. It is rated at over 1 amp; this will give you plenty of spare power for other ZX add-ons. The RAM pack is manufactured with high quality materials, and uses high-speed low power RAMs. The 16K is also available in a kit version with a saving of £10. The kit is very simple to put together but you must have a knowledge of soldering. The same power supply is also supplied with the kit (as above) and a full set of instructions, diagram etc are included.

16K 81 SOFTWARE

DEFLEX. This totally new and very addictive game, which was highly acclaimed at the Microfair, uses fast moving graphics to provide a challenge requiring not only quick reaction, but also clever thinking. One and two player versions on same cassette. £3.95

3D/3D LABYRINTH. You have all seen 3D Labyrinth games, but this goes one stage beyond; you must manoeuvre within a cubic maze and contend with corridors which may go left/right/up/down. Full size 3D graphical representation. £3.95

CENTIPEDE. This is the first implementation of the popular arcade game on any micro anywhere. Never mind your invaders etc this is positively shining, the speed at which this runs makes ZX invaders look like a game of simple snap. £4.95

Please add £1.00 p/p for all hardware.

Software p/p free.

Specify ZX80/81 on order.

ALL OUR PRODUCTS ARE COVERED BY A MONEY BACK GUARANTEE.

4K GRAPHIC ROM

The dK Graphic module is our latest ZX81 accessory. This module, unlike most other accessories, fits neatly inside your computer under the keyboard. The module comes ready built, fully tested and complete with a 4K graphic ROM. This will give you 448 extra pre-programmed graphics; your normal graphic set contains 64. This means that you now have 512 graphics and with their inverse 1024. This now turns the 81 into a very powerful computer, with a graphic set rarely found on larger more expensive machines. In the ROM are lower case letters, bombs, bullets, rockets, tanks, a complete set of invaders graphics and that only accounts for about 50 of them; there are still about 400 left (that may give you an idea as to the scope of the new ROM). However the module does not finish there: it also has a spare holder on the board which will accept a further 4K of ROM/RAM. We have a tool kit ROM (coming soon) which will use this holder. You could also use this holder with a 411B (1K) or 6116 (2K) RAM chip, and then have user definable graphics, should you wish to define your own graphic set. Machine code can also be stored and run if you fit a RAM in the holder. As you can see this is not one add on, but three — all of which are very useful additions to your computer. You can also use the spare holder for your own programmed EPROMs. The graphics are all available from your keyboard under SOFTWARE control: no buttons or switches and no special routines.

dK'tronics

23 SUSSEX ROAD, GORLESTON, GREAT YARMOUTH, NORFOLK.
TELEPHONE: YARMOUTH (0493) 602453



Micros come to Croydon

David Pollard visits a thriving south-London group.

CROYDON MICROCOMPUTER Club is definitely thriving — its two meetings a month at the borough's Central Reference Library attract between 40 and 100 members and a variety of machines. ZX-81s are understandably popular with UK101s a close second, plus a representative selection of the more expensive machines.

A few of the first batch of BBC Micros have now arrived and are being put through their paces with interest. The on-board sound chip of the micro might well lead to the computer becoming the 1980s' equivalent of the electric guitar.

The club was founded in 1980 and originated, as do many such projects, from conversations in the local hostelry. After a meeting of their club, five or six members of the British Computer Society, which is also based in Croydon, were discussing the need for a local micro club — from that it just grew.

It has certainly snowballed and the connection with the BCS has been maintained. The "mainly mainframe" men were evidently impressed when Croydon MCC took along a selection of tiny machines — to them, anything less than 5Mbyte memory — to a recent BCS lecture about the power of the micro.

There remains a reciprocal agreement whereby members of one group can attend the other's meetings. Outsiders also are welcomed — the associate membership fee is a modest 50p.

The club's success has been ascribed to three main reasons: there is a core of senior members with experience and dedication; meetings are not held too frequently with the result that the quality is kept high; and the meetings are held on a regular basis.

The first meeting of the month takes the form of a formal talk on subjects such as networks, word processing and operating systems. The second is for special-interest groups where the members divide into bunches of five to 10 to teach and learn Basic at various levels, machine code, hardware techniques, specialist programming, and to work on various projects.

Sound production

David Annal is the secretary: his Interface Symposium was certainly stimulating and gives a good example of one of the formal talks. Having covered the means of entering signals, analogue and digital, into the computer, he illustrated the techniques used to obtain suitable outputs with the example of sound production.

Starting with a single-wire output, 5V switched on and off, smoothed a little, and fed into an amplifier, no-one was left in any doubt as to the apparent ease with which Space Invader effects could be produced. Indeed, the BBC's Radiophonics Workshop could not have done much better.

Then Petsoft's Audio Calculator gave an intelligible speech output — amazingly still from a single-wire digital output. The addition of a ladder network gave an eight-bit converter for analogue output; though Händel may not have approved entirely, the four-part harmony was certainly melodious.

The Audiogenics Visible Music Monitor showed a four-part score as the music was played. David Annal reckons that he knew hardly anything about music before starting with these programs.

Vernon Gifford, chairman, is one of the main driving forces behind the club's activities. He is quietly spoken, sincere, with a properly measured enthusiasm and a keen intellect. One wonders how he finds the time for all that he achieves; he also does a good deal of work for the Association of London Computer Clubs, the Amateur Computer Club and the BCS.

He and David Annal are closely involved with the organisation of the fourth London Computer Fair which will be held at the North London Polytechnic at Easter.

One of the Special Interest Groups of Croydon MCC is working to develop computer aids for mentally-handicapped, Downs' syndrome children at a school in Selhurst, in the north of the borough. These children cannot work a keyboard so the programs have to use simple input and output.

Necessary work

For example, there are games where the children recognise shapes like street signs, or press any key the number of times that an object appears on the screen so as to learn to count.

The use of a Nascom and voluntary labour keeps costs to a minimum. Precious little funding is available for what seems to be very necessary work such as this.

One group organised by the club is on Saturday morning and the second takes place on Monday from 4.30pm to 7pm for more advanced teenagers: Vernon Gifford takes an active part in both. David Johnston is the junior secretary, keeping track of membership and helping with administration.

The reckoning is that these computer groups are a vital supplement to computer studies in schools — they provide an opportunity for hands-on experience which is hard to find at a school with only one computer for several hundred pupils. ■

Computer Club is here to encourage you to start your own local computer club or, if one already exists, to join it and become involved. Each month we will devote the page to new ideas from local clubs. We would like to hear of anything which has made a club a success, or of any projects or programs you are developing.

REVIEW

THE BBC MICRO

Predicted sales of the BBC Microcomputer have mushroomed from an original estimate of 12,000 to possible orders of 100,000 during 1982. Tim Hartnell assesses one of the first of the £225 systems to leave the production line.

THE BBC MICROCOMPUTER is a joy to use, with flexible colours and an incredibly fast Basic of its own which has more facilities than you are ever likely to use. I must qualify this glowing praise by pointing out that the review machine was a pre-production model. One may take for granted that some of the facilities it lacked will be present in the commercially available model.

The BBC Microcomputer looks, at first sight, like an extended Atom, with a broader area behind the keyboard. There are 10 user-definable function keys at the back, but no separate numeric pad. The keyboard is very sensitive, like a good electric typewriter — as the BBC specification demanded — but the model I used was almost too sensitive and led to inadvertent double-striking time after time. The keyboard means touch-typists can program as fast as they can type, but I feel Acorn have overdone the sensitivity a little.

The processor is a 6502A, operating at 2MHz. The review computer was running at half speed, but was still extremely fast. When I converted one of my Life programs, written in Basic and which takes about 20 seconds a generation on the ZX-81, about four seconds a generation on the Atom, I found it took about 1.5 seconds on the BBC machine — speed indeed.

In a more formal test of the machine's speed, I ran a simple loop — count from zero to 1,000, printing out each number during the loop — on the Atom, the MZ-80K in Basic and in Pascal, and on the BBC machine. The result were:

- Atom — 1 minute 23 seconds
- MZ-80K, Basic — 50 seconds
- MZ-80K, Pascal — 22 seconds
- BBC Microcomputer — 14 seconds

The Atom time is so bad because the routine to Print takes a good deal of time-consuming care to keep the display snow-free.

The BBC Micro's Basic ROM occupies 16K, and the machine operating system a further 16K. The BBC says much of its software will call up monitor routines. There are two computers in the range, model A, which will sell for around £225, and the more flexible model B — around £335. The review machine was a model B.

The 73-key keyboard has the full QWERTY layout, the user-definable function keys, four cursor-control keys in the top right-hand corner marked with arrows, two-key rollover and auto-repeat.

The display is very flexible, but I feel the designers have made some very peculiar decisions. There are eight display modes, with zero to three available only on the more extensive model B. The graphics modes are:

Mode 0: High-resolution — 640 by 256 — two-colour graphics and 80-by-32 text.
Mode 1: High resolution — lower, in fact, 320 by 256 — four-colour graphics and 40-by-32 text.
Mode 2: 160 by 256, 16-colour graphics and 20-by-32 text. This is where I feel one strange decision has been made. The only mode which gives access to 16 colours has a very broad text of 20 characters across which is almost unreadable without a full blank line between each line of text The colours in mode 3 are superb and because of the wide range, this is the mode most model B owners will probably prefer. After all, 160 by 256 for graphics is an acceptable degree of resolution. Yet because the text is so broad — is it designed to be read at the back of classrooms? — the use of mode 2 will be somewhat restricted.
Mode 3: 80 by 25, two-colour text.

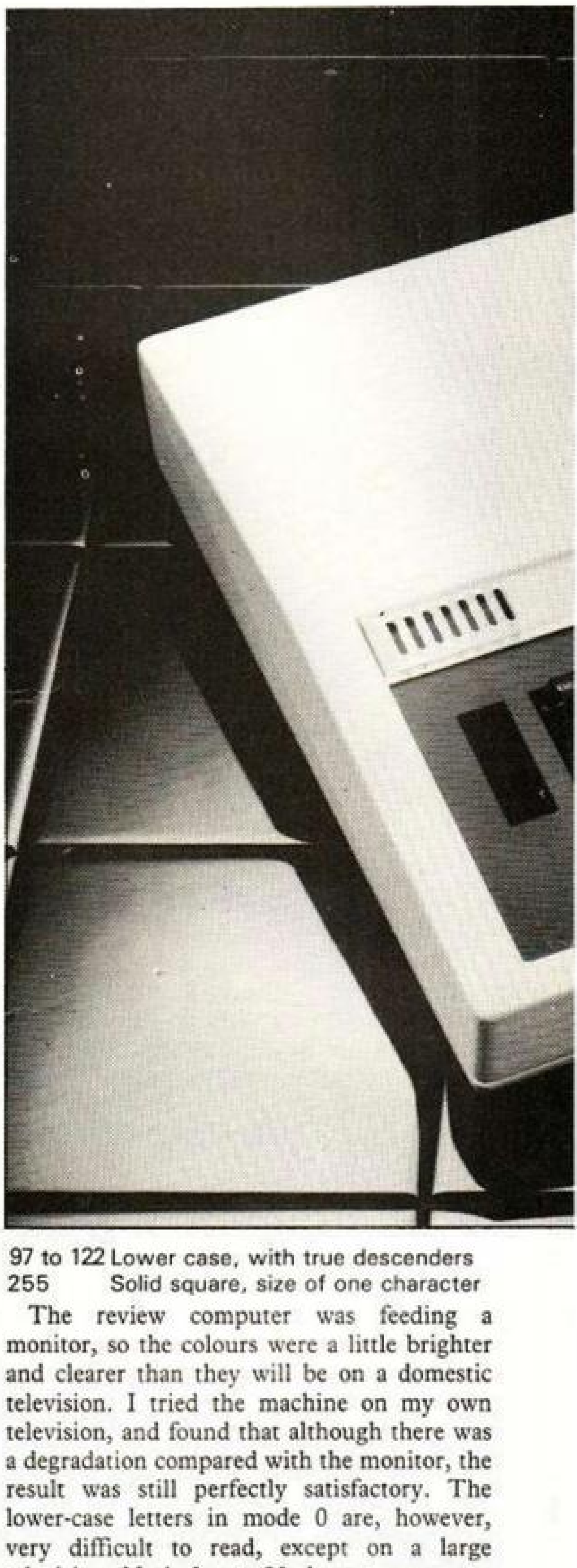
Model A supports only modes 4, 5, 6, 7 which are also, of course, supported by model B. The additional modes are:

Mode 4: 320 by 256, two-colour graphics and 40 by 32 text.
Mode 5: 160 by 256, four-colour graphics and 20 by 32 text.
Mode 6: Two-colour text.
Mode 7: Standard teletext display.

The colours you obtain in the two-colour mode are either black and white or certain pairs which you can call up with a command called VDU. The four colours are black, white, orange and yellow, but these can be changed using VDU.

The text, except for the broad mode 2, is very clear, with added extras such as a true $\frac{1}{2}$ and $\frac{3}{4}$, plus little arrows, lambda, square root, a proper division sign and "approproximately equal to". The character set can be easily redefined using the VDU command. The character set, with a few of the control characters, includes:

Code	Result
12	Clear screen and home cursor
30	Home cursor without clearing screen
31	Move cursor to specified location — used as PRINT CHR$(31),X,Y
157	Reverse colours of a single line
48 to 57	Numbers 0 to 9
65 to 90	Upper-case letters A to Z
97 to 122	Lower case, with true descenders
255	Solid square, size of one character



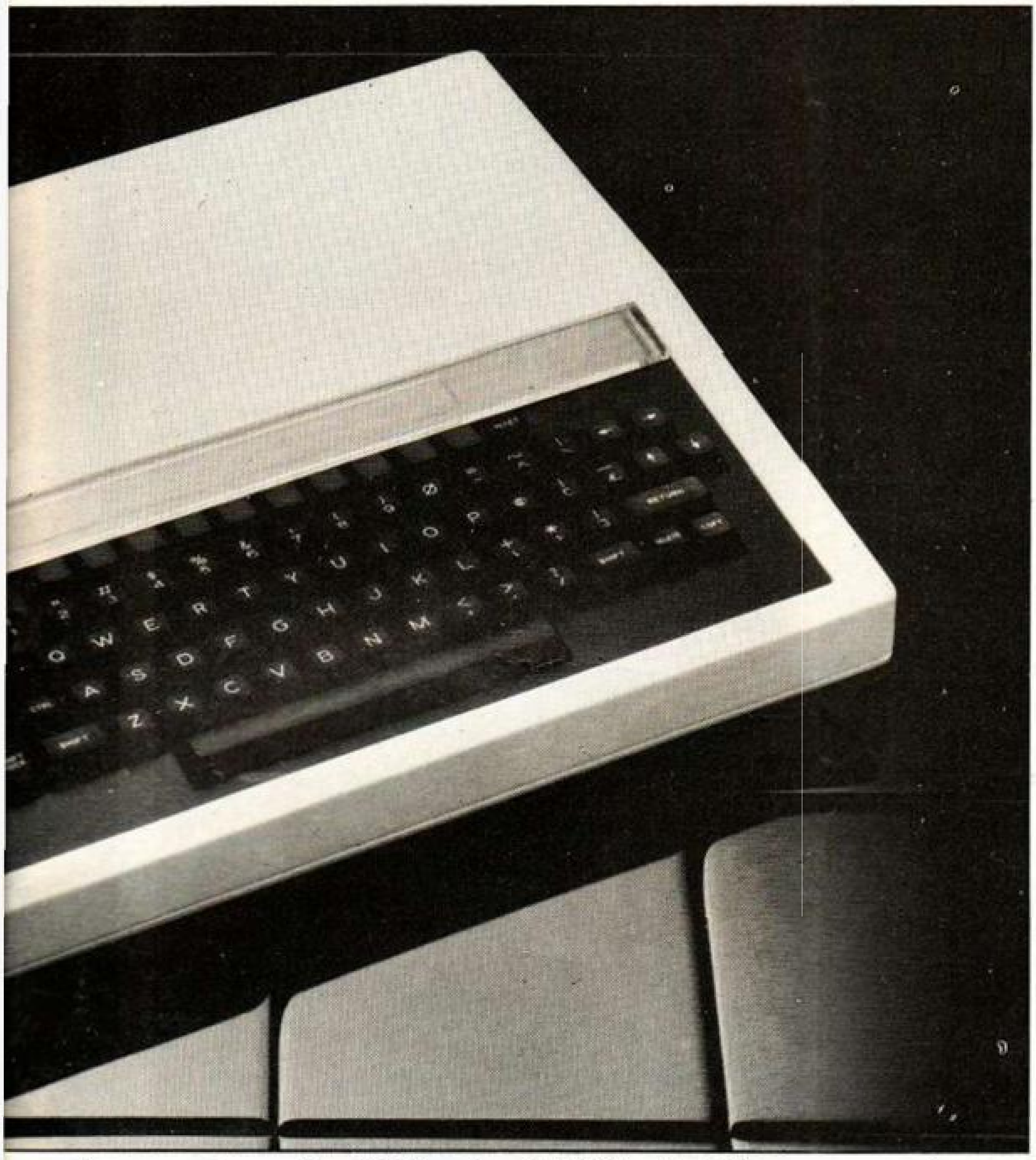
The review computer was feeding a monitor, so the colours were a little brighter and clearer than they will be on a domestic television. I tried the machine on my own television, and found that although there was a degradation compared with the monitor, the result was still perfectly satisfactory. The lower-case letters in mode 0 are, however, very difficult to read, except on a large television. Mode 0 puts 80 characters across a single line.

Room for expansion

The computer contains a three-tone music generator, which has the full envelope control of attack, sustain and decay, and which feeds an internal loudspeaker. The machine emits a quiet "beep" when you turn it on.

Model B is, as expected, far more flexible than the model A, and is equipped with a variety of I/O ports. There is a user eight-bit parallel input/output port, and four analogue inputs for games, paddles or control applications.

One of the real strengths of the Atom is the way it was designed as an opened-ended system, to accept a large number of peripherals. The BBC machine follows this lead, with room inside the case for adding such things as interfaces for floppy discs,



Econet or the cartridge ROM packs. A speech-sythesis unit will be available which will also fit within the case.

There is also space for a "tube" connector for connecting a second processor. The BBC computer is designed so it can be expanded to run with a second processor and considerably expanded memory.

All the units which will connect via the tube are still in the development stage and will not be available for some time. The BBC says the units will include a 3MHz 6502 processor with 60K of RAM, a Z-80 processor with 60K RAM running CP/M, and 16-bit processor with 128K RAM.

From these plans it is clear that the BBC Microcomputer has been designed with an eye to the future, to ensure it does not become obsolete quickly.

The second 16K language ROM contains a 6502 assembler along with the Basic, as does the Atom ROM, so Basic and assembler may be mixed within a program. There is space within the computer for up to four 16K language ROMs which are paged. ROMs under development include Pascal and a word processor.

The teletext display has all the features of standard teletext, including flashing and the double-height option.

The error messages are unambigious and polite — what else could we expect from a BBC machine? The error messages, in upper- and lower-case letters, include:

- Missing, at line 100
- Syntax error at line 100
- No such line — if you try to Goto or Gosub without a destination.

These are of great aid in debugging, as are Trace On, Trace Off, Trace X and Trace line-number.

The BBC machine shows evidence that a great deal of thought has gone into its creation, and demonstrates that Acorn has learned much from its experience with the Atom. Atom thinking permeates the machine, but the BBC machine design has weeded out the more idiosyncratic features of the Atom without sacrificing speed and flexibility.

The most notable hangover from the Atom is the use of the query "?" for Peek and Poke; its context determines which it is. For example, in the following Basic statement

```
IF ? A = 9
```

suggests Peek, while

```
? A, 98
```

indicates Poke.

There are some very useful features to save programming time. These include Auto which automatically numbers lines, starting at 10 and incrementing by 10 unless another option is chosen. Renumber, used as a direct command, is virtually instantaneous, and renumbers Gotos and Gosubs as well as the line numbers. Unless another option is specified, Renumber starts at 10 and increments in tens.

Those familiar with Atom Basic, and with some other implementations of the language, will be pleased to find the BBC machine accepts the same abbreviations for keyboards as the Atom, such as

P.(PRINT) R.(RETURN) L.(LIST) G.(GOTO).

Many first-time computer users are understandably bewildered when they first unpack and connect up their new toy. Unlike a record player or a television, a computer generally does not do anything at all, and certainly never does anything impressive unless it is told to do so.

Friendly manual

The BBC provides a cassette of programs marked "Welcome" which contains routines to help you have the computer up and running from the moment you manage to wiggle the seven-pin DIN plug into place. The initial package includes the computer, a two-metre long aerial lead for the TV or monitor, a computer-to-cassette lead, the "Welcome" cassette and a very comprehensive and surprisingly unstuffy manual. The cassette contains 16 games, and demonstrations, including Biorhythms and Clock.

The user's guide is divided into four sections. The first part tells you how to connect up the machine, and includes some simple, but impressive, one-line demonstrations to show the flexibility of the graphics commands. The second part of the guide purports to be an introduction to Basic but, as the manual admits, is really too brief to be of much use for the absolute beginner.

The third section goes through BBC Basic, command by command, with sample program lines showing the command in context, and associated keywords. The associated keywords for Restore, for example, are Read and Data.

The final part of the guide is a meaty reference section, giving an outline of the operation of the built-in assembler, the machine operating system, and such things as a memory map. Further technical manuals are planned to expand the information.

CONCLUSIONS

- The BBC Microcomputer is a splendid machine, with many avenues for exploration.
- Acorn and the BBC have done their work well, producing a machine which is better than the market demands — it is even over-specified. By doing this they have ensured they will probably not be able to meet the demand for the machine once word travels as to how good it is.
- They have also ensured that it will not become obsolete quickly, and they have earned the undying hatred of every other manufacturer of £200 micros. ■

REVIEW
WORD PROCESSING ON

The low-cost Seikosha GP-80 printer coupled with WordPack can transform the Acorn Atom into a word-processing system capable of dealing with most applications outside the office. Norman Kirby reviews.

AT £230 INCLUDING VAT, the Seikosha GP-80 is the least expensive wide printer available. The Tandy Personal Line Printer VII is now about £10 more expensive and following it is the new, more sophisticated Roxburgh RX-8000-FF at slightly more than £250. The Tandy machine is made by Seikosha, but is a different model from the GP-80 — Tandy claims it is a more advanced one — and to interface it to non-Tandy computers requires an effort.

The GP-80 is available in three or four sub-models but it is not always easy to spot the difference between them. Some have European characters as well, and the standard interface is different. They all seem suitable in principle for most computers. I shall describe the GP-80M sold by Nottingham-based Leasalink Viewdata Ltd, the main distributors of all Acorn products, and others which can be used on the Atom.

Leasalink charges £232 for the printer including carriage and complete with a 3ft. ribbon cable, a plug and a socket to connect the printer and the Atom, 6ft. of mains cable and 100 sheets of paper.

To prepare a minimal Atom, a 6522 versatile interface adaptor (VIA) and a LS-244 buffer must be plugged into the appropriate sockets already on the board. Also, you must solder a 26-way PCB plug on to the board as described in the Atom manual. A simple wire link needs to be soldered between two pins in the board — only a 20-minute job if you follow Leasalink's instructions. Use a soldering iron with an iron tip about 1mm. in diameter to avoid the risk of bridging pins. The VIA and buffer cost £10.35 but are, of course, available from many suppliers; the PCB plug costs £4.75.

Be careful when inserting integrated circuits into sockets: the pins are easily bent. I use a jeweller's eyeglass and inspect meticulously while the circuit slides home. The socket at the Atom end of the ribbon cable can be inserted the wrong way round. The cable should fall downwards when viewed with the Atom the right way up.

Printed result

The printer produces the full 96-character ASCII set and uses the common five-by-seven dot-matrix system. Like many other similar inexpensive machines, it cannot underline and does not print lower-case descenders. Underlining can easily be done manually; descenders cannot. This is, however, no problem and you soon grow used to them.

The printed result is very clear and neat with a satisfactory degree of uniformity. It is



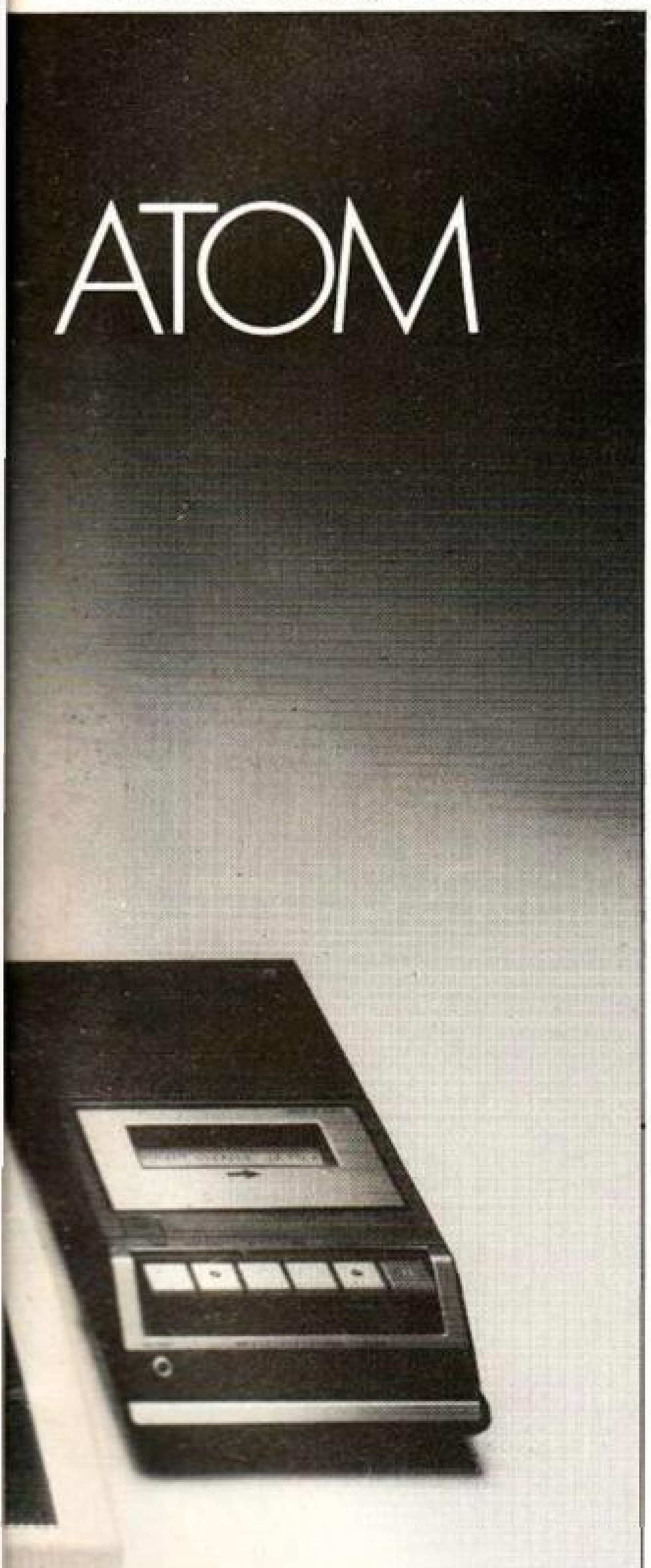
not, perhaps, as sharp and clear as more expensive five-by-seven dot-matrix machines, but it is good.

To enable the printer, you must execute Print $2 either from the keyboard or from a program, or press CTRL and "B". Everything printed on the screen will go to the printer. To disable, execute Print $3 or press CTRL and "C".

The printer can also print double-width characters which, by an optical illusion, appear higher. The result is the appearance of a larger type-face which is very impressive for headings to, say, letters and tables.

To obtain this, you execute Print $14, and to cancel it, Print $15. It prints as fast as any home computer user could wish — 30 characters per second, with up to 80 characters per line. The average A4 sheet typed with a conventional typewriter in a small type-face fits about 70 characters into the line.

Fan-fold paper is available at about £8 per 1,000 sheets including VAT, plus carriage.



That is a reasonable price although a little more than stationers' A4 paper. It is of adequate quality for most applications. The paper is 8in. wide with tear-off perforations every 12in. That is a little narrower and longer than A4 and the maximum width the printer can take is 8in. — the minimum is 4.5in.

There are no perforations vertically along each side to allow removal of the sprocket holes but these can easily be cut off with a razor to improve the appearance of a letter. The copy paper available means you can obtain two duplicates simultaneously.

The paper is easy to feed in — aided by a feed-forward wheel — but I would have appreciated some way of moving the paper backwards without having to disengage and re-engage it. The ribbon is in a replaceable cassette. The manual is satisfactory.

The Seikosha can also print graphics. Since each dot is the size of a pinprick the resolution is very high. Leasalink supplies a medium-length assembler program to dump to the printer a full screen of Atom Mode 4 graphics. A screen holds 256 spots horizontally and 192 vertically.

You generate a screen of graphics in the usual way and, having previously assembled the dump program, Link to it — other computers would use USR. The graphics are then printed occupying an area of 3.6in. wide by 3.5in. high. It takes about three minutes. The Leasalink program prints the graphics in the middle of the page with a thin border but this software could easily be modified.

Briefly, a word processor is a keyboard, a screen, a printer and a memory store. It allows you to create and edit text on the screen. You can correct errors, change letters, words, sentences or paragraphs, and interchange passages, until you are satisfied. When all is as you require, you can obtain a printout of the text. Further alterations can be made after printing by amending only the parts to be changed, and reprinting. The whole page or document need not be typed again. The text following the change is respaced to allow for the insertion, or contracts after a deletion.

Novel feature

The Atom word processor, WordPack, costs £30 including VAT and is available from Acornsoft, Leasalink and several other dealers. It is a 24-pin ROM which fits into the spare utilities socket provided on even the minimal SK-24 Atom board. A novel feature is that the top of the ROM has a small transparent window through which you can see the chip.

The Atom will continue to operate normally but will accept two new commands — Edit and Text; the first spawns 43 further instructions. The advantage of a ROM over a taped or disc program is, first, that the ROM does not use precious RAM, and secondly, there is no time-consuming loading — not such a significant plus if you have a disc.

To use the WordPack, execute Edit and the screen will clear as for Mode 4 graphics. Answering the prompt "Old text?" produces a rectangular end-of-text marker at top left with p01> at bottom left. That means "page 1" followed by a prompt. Type "e" and enter some text. Press Copy and it will be deleted and transferred to the top of the screen. The keyboard works just like a normal typewriter, with upper- and lower-case letters selected by Shift.

If you continue to enter text, it is transferred to the top of the screen from time to time in blocks of up to 488 characters. When you want, the text at the top can be edited. There is an underline-type cursor which can be moved using the normal cursor-control keys. Position it under a character, press delete, and it will disappear. If you press "i" and a single character key, that character will be inserted immediately before the cursor.

Press "x" for exchange and a single character key, and that character will be exchange for the one above the cursor. Alternatively, if you press "a" and enter a passage of text up to 488 characters long, press "copy", the passage will be inserted immediately after the cursor. By pressing "b" the same can be accomplished before the cursor.

Another editing technique is to move the cursor to the start of a piece of text which needs attention. Press "@", move the cursor to the end of that piece, so marking it. You then can either press Delete and the marked piece will disappear or press "r", enter a passage of text, and press Copy. The new passage will replace the marked piece. Alternatively, press "t" for transfer and the marked piece will be deleted and stored in a temporary buffer.

Powerful command

Using the "a" or "b" operation described will then insert it in another place of your choice in the text. In this way sentences and paragraphs can be repositioned. The displayed text can be paged forward and back using single keystrokes, and it can be scrolled up.

A powerful feature is the find-and-replace command. You can ask WordPack to find and present a specific word or string of words each time they occur. Equally, you can ask WordPack to substitute another word or string of words. After examining each individual instance, you decide whether it should be replaced, or you can specify that it should be replaced throughout the text.

This command allows you to correct, say, a certain spelling mistake you have discovered. It also allows you to use abbreviations to save typing: when the text is complete, you replace each abbreviation with the full word — for example, "b.s." could stand for building society.

Because a computer program can be edited just like text by using the Text command, spaces can be eliminated and fully-written commands can be replaced by their abbreviations — Goto replaced by "G".

You must, of course, include commands for indentation, lines per page, page numbering, justification or not, single or double spacing, automatic centring or not of individual lines, preventing a table or list being split between two pages, starting a new page, stopping printing for a new piece of paper — if you are using single sheets — and printing in single or double-width characters. You can also set the right-hand margin.

These commands take the form of a full stop followed by a lower-case letter, and must be

(continued on page 21)

(continued from page 19)
placed at the beginning of a line. For example, ".i10" means indent 10 spaces until further notice; ".160" means 60 lines per page, ".o14" means print double-width characters until further notice and "o15" cancels that; ".t4" calls for an indent of four for that line only. They default to the most convenient arrangement if no command is given.

Text can be saved to cassette or disc and loaded without interfering with the display, and the commands are a simpler version of the usual ones. Pressing "w" will give the address of the first free memory location after the text, allowing the *Load command to append a further file of text on the end.

Acornsoft's high-speed cassette-saving and loading program can be used to speed up these processes. The Atom's highly-reliable loading is a boom. A saved file can, of course, be loaded and amendments made, then printed. The only typing involved is that for the actual amendments.

The only significant omission I can find is the lack of a tabulation command. Acorn says that it will be releasing a cassette which contains software to add that facility together with the ability to print a title repeatedly on each page. Acorn is also producing a disc system for the Atom at about £299.

The memory requirements are 6K of RAM in the upper text space for displaying the text, and whatever you have in the lower. The text starts at location # 2800 if the floating-point ROM is fitted, # 2900 otherwise. Here 5K will hold the equivalent of three A4 pages of conventional single-spaced typescript using a medium-sized type-face. The Atom can hold up to 21K in this area. Larger documents can be split and entered, processed, saved and printed as consecutive sections.

It is acceptably crashproof. Acorn has ensured that nearly all invalid key strokes are ignored. However, I have managed to crash it a few times. Usually, pressing Break, executing Edit, and making a minor repair to the beginning of the text effect a recovery.

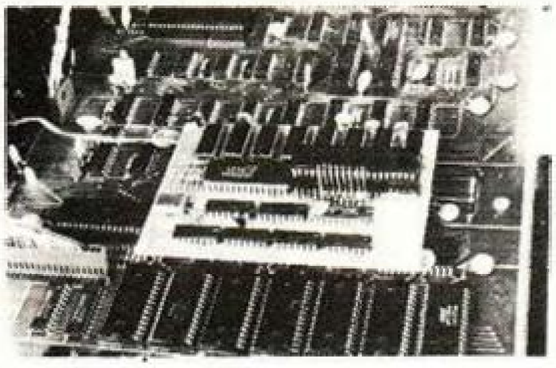
WordPack is a delight to use and I never want to touch a conventional typewriter again. Of course, £30 will not turn your Atom into an expensive, office-type word processor, but you have the essentials. It is definitely a serious package and in no way a toy.

It is useful for letters, club membership and fixture lists, leaflets, articles, recipes, reports and circulars. It is worth considering for office use — the whole cost of an Atom, printer and ROM is slightly more than £550 including VAT but excluding a cassette recorder and TV or monitor. It would be pointless, however, to consider it without a printer.

CONCLUSIONS

- The Seikosha Printer at about £230 including VAT, ribbon cable and some paper is the least expensive wide printer on the market, and it should interface easily to most computers.
- It prints all 96 standard ASCII characters in a five-by-seven dot matrix but lower-case letters do not have descenders. Double-width characters can be printed.
- The printed result is neat and attractive and can be used for letters although it is not, of course, as good as expensive letter-quality machines.
- It can also print graphics which, at least with the Atom, are very attractive. With each dot the size of a pin-prick, the resolution is very high.
- With a printer, the £30 WordPack ROM turns the Atom into a thoroughly practical tool for the home, club and also the small office. The ROM plugs into the spare utilities socket on the Atom board. The computer works normally but WordPack is instantly available on executing one command.
- Computer programs can also be edited and transferred to the upper text space for running.
- All the really essential facilities of word processing are available. The only significant omission is the ability to specify tabulations. However, Acorn is producing software on cassette to add this and repetitive page headings.
- The word processor is a delight to operate and makes the conventional typewriter seem an anachronism. It is good value for money. ■

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INTERVIEW
KENNETH



In January 1981, Kenneth Baker MP became the first Government Minister with responsibility for Information Technology — an all-embracing term covering everything from space satellites to Sinclair ZX-81s. He talks to Duncan Scot about his hopes for reversing Britain's decline and his plans for the future.

KENNETH BAKER IS the force behind the designation of 1982 as Information Technology Year, the year the Government hopes to use its considerable propaganda skills and power to push a new message across to individuals and industry. That message is that unless we use new technology now, our living standards will not only lag behind those of our industrial competitors but will, for almost the first time in centuries, stagger into absolute decline.

Kenneth Baker had a conventional background for a Conservative minister. He was born in 1934 and educated at St Paul's and at Magdalen College, Oxford. During his national service, from 1953-55, he was a lieutenant in the Royal Artillery in North Africa and also an instructor to the Libyan Army. During his time at Oxford from 1955-58 he was Secretary of the Oxford Union.

Soon after Kenneth Baker first entered Parliament he was described as a Peter Walker clone, articulate, fond of satire and casual in his dress, although only by the austere standards of Conservative ministers. He is also something of a rarity in that he is often billed as a minister who actually knows something about his subject.

"Although I have been involved in computing for some time I am not a trained computer man at all — I studied history at Oxford. When I came down in 1958, I moved straight into general management working for several companies. In the early sixties I ran companies, groups, sometimes public groups, working very much to pull them round.

"Doing that I discovered the advantages of using computers. This was in the very early days of computers, but there were definite advantages in doing jobs like payroll and simple stock control."

In the meantime, he was working hard within the Conservative Party. He served on Twickenham Borough Council from 1960-62 and contested a number of elections before finally entering Parliament in a by-election in March 1968 as member for Acton.

"It was when Wilson was at the absolute trough of his popularity — I won the by-election in an even bigger swing than the SDP did in Crosby in November. So I won a Labour seat in 1968 but it went back to its rightful home in the general election in 1970. Then I won a by-election in Marylebone three months later. I was very lucky to have been given the first by-election to come up when Lord Hailsham became the Lord Chancellor. I think I have the record for the shortest gap between two seats.

"In 1972 I joined Ted Heath's Government as a junior minister in charge of the Civil Service Department where I found, among other things, the Computer Agency being set up. There were two things which particularly interested me then; they were the HMSO and the Computer Agency. I put management accountants into HMSO to try and turn it into a commercial operation. It takes a long time for those kinds of thing to happen.

"I also ran the Computer Agency and took a very considerable interest in that. It was really a buying agency for the Civil Service. The particular policy I followed, and it was well known at the time, was to increase the amount of business being pushed out to the software houses of Britain and giving every little bit of encouragement along that particular road".

Kenneth Baker's present job must give him a certain sense of *déjà vu*. In 1972 he was involved in the then rescue of ICL, the State-backed computer company. In 1982 he found himself again responsible for trying to push the company back on to the road to commercial viability. He was largely responsible for persuading the Government that it was worth another try with new management, rather than selling the company off to a foreign computer agency. ICL now has £200 million of Government guaranteed loans.

'Government should be co-ordinator and catalyst'

The Conservative Government was defeated in the general election of February 1974 and Kenneth Baker returned to the back-benches of Parliament and to business, spending more of his time as a consultant. As a Parliamentary Private Secretary to Ted Heath from 1974-75 he was regarded very much as a Heath man, an advocate of state intervention to support and help certain industries and was left out of the Government formed by Margaret Thatcher in 1979. He remained very active, however, writing numerous newspaper articles, making speeches and working within the Conservative Party and on various committees.

One speech he made in June 1980 is now seen as the turning point in his career. In effect, he detailed his own job specification. In the speech, at a business telecommunications conference, he outlined a "National Strategy for Information Technology" which included a 10-point programme. Many of the 10 points have now been sanctioned.

The first was the appointment of a Minister of Information Technology who would act as a focal point in Government for this diverse industry. He went on to demand that schools should be provided with small and low-cost personal computers and software systems and that British companies should be asked to design and supply these; that a national training programme in the new skills should be started at all levels, from schools to universities including both teachers and pupils.

As he said in his speech, "The opportunity in this country is immense and we must not let it slip between our fingers. It is a fiercely competitive industry. Since every developed country has reached the same conclusion, their governments have decided to involve themselves in promoting or protecting their own information-technology industry. The Japanese government, for example, has injected £1,100 million into the industry to catch up with America. I am not arguing for vast state intervention — the role of the Government should be that of co-ordinator and catalyst".

"I drew up the specification for

BAKER MP

this job and decided that as a country we had to pull together all the activities in this area. I was fairly critical, before I became the Minister, of most of the departments in the Government because I did not think they were putting their acts together. I was critical of the Department of Education because I did not think they were — they are now — really giving enough consideration to high technology. In all fairness, they had allocated £9 million very much for software development and teacher training, which is a very important part.

"The scheme I have introduced, Microcomputers in Schools, would not have been introduced without support from the Department of Education. I provided the catalyst. I provided the money for hardware for micros in schools. It is a very successful scheme and I am very proud of that. Slightly more than 3,000 secondary schools did not have microcomputers and we have already helped 2,000 of them — a great success story".

Under the scheme, the Government promises to pay half the cost of either a Research Machines 380-Z or

'I am very keen to promote British hardware'

a BBC Microcomputer for any school which does not already have any microcomputers. The other half of the cost has to be met by the school, the Local Education Authority or by parent/teacher associations. As from January 1, 1982 the scheme is being extended to those schools which already have some equipment. Independent schools have to apply through the National Computing Centre in Manchester.

Kenneth Baker is also planning to run a second Schools Computer Competition in which 100 computers are given away in prizes to those schools which submit the best essays describing how they would use a personal computer. Last year's competition attracted considerably more than 600 entries. This year more than 1,000 schools have indicated that they will enter.

He does not accept the view that there is no need to train the teachers. So many computer users now buy their computers mail-order and manage to teach themselves how to program, that some people are doubtful of the need to spend £9 million on training teachers. "That is splendid", says Kenneth Baker. "Clive Sinclair in particular is a marvellous man. He has really broken through with cheap personal computers. But if you are to put personal computers in schools and teach children you must have the staff to do it.

"On the other hand, some lovely stories have filtered back from some of the schools which have the personal computers. In one school one of the sixth-formers sat down and really mastered the school's personal computer and is now holding training sessions for the teachers".

Another of the well-known areas for which Kenneth Baker has responsibility is videotex, that umbrella term covering everything from broadcast teletext to British Telecom's Prestel service. The speed at which the British Prestel service has been adopted has fallen considerably behind British Telecom's published forecasts.

"I think Prestel has been slow", says Kenneth Baker, "because British Telecom went for the domestic market, and the domestic consumer is often, quite justifiably, worried about the extra cost. I can see why British Telecom wanted to go for that market. There are many unused telephone lines outside business hours.

"Yet Prestel is taking off now in private viewdata systems. There is no question about that. We have tried to pull the whole thing together. Last year has been a considerable breakthrough so far as teletext is concerned. The Teletext Month in October 1981 was a great success. Something like 20 percent of the sets sold, I am told, have a teletext facility. People are now used to seeing screens with information on them. This is something of a breakthrough in familiarisation. I hope by the end of 1982 there will be at least a million sets installed with full teletext facilities. I would hope that by 1984-85 virtually every set which is sold will automatically have teletext facilities.

"The Prestel side will, I think, take just that much longer to get off the ground. As far as the consumer is concerned, teletext is just another button on the television set. If you have Prestel it is telephone time you

'A breakthrough in familiarisation'

are using and most people reckon that that is expensive, which it is".

Kenneth Baker was unaware of the scale on which British-made Prestel adaptors, such as the Tantel unit, are being produced. He thought that most adaptors cost about £200 and were imported from abroad. "You have drawn my attention to the Tantel and it sounds very interesting. I will look into it. This is the kind of thing I am looking at to see if I can give some assistance in one way or another — through trade not aid.

"I am very keen to help promote British hardware products. The Micros in Schools scheme has done very well with the Research Machines 380-Z and the BBC Microcomputer".

The full range of Kenneth Baker's responsibilities extend somewhat beyond personal computers. He has persuaded the Government to declare 1982 Information Technology Year. This has been criticised by some commentators as just bringing together various existing Government initiatives, from satellites to personal computers, under one title.

"That is very unfair. There are many projects I have announced which I do not believe would have been possible to get off the ground without focusing attention on the whole of the information-technology area. The importance of Information Technology Year is that we are putting it into high profile. Several of the projects I have announced would simply not have happened had I not done this. For example, the Information Technology Centres and I am doubtful if the Schools Scheme would have happened otherwise.

"I think this is probably the only government in the world which has actually pulled the threads together under one administrative head. We no longer have a myopic view of each industry. I also have a unit at the Cabinet Office, under the Home Secretary, which co-ordinates Government activity in this area. I also have six independent advisors. None of this would have happened unless we had made it happen.

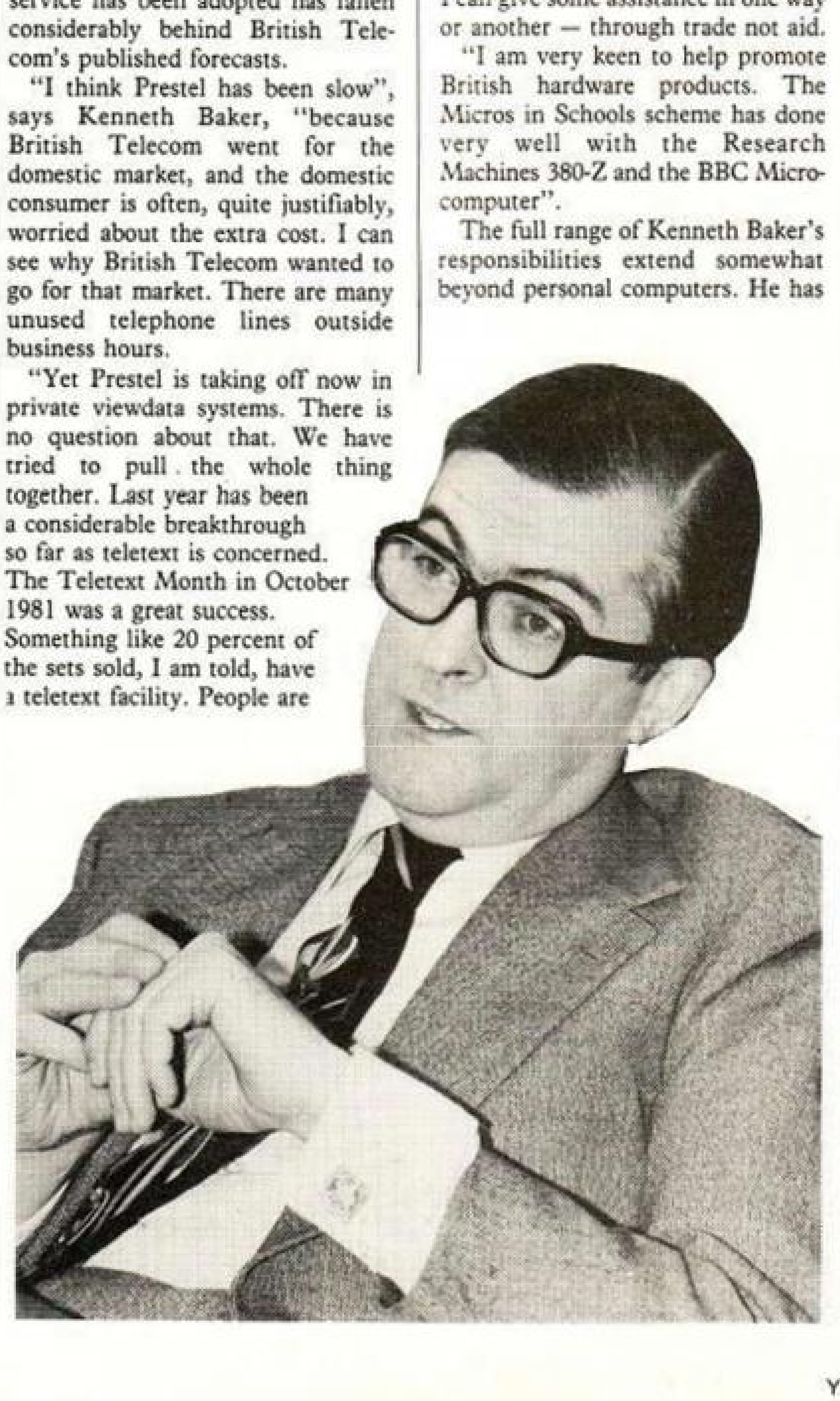
"To believe that a thousand flowers will just pop up all by themselves without fertiliser, without the propagation of seeds is a little naive".

All the same, Kenneth Baker accepts that the Government has appeared on the scene a little late in the day, now that the personal-computer industry is firmly established with up to 300,000 microcomputers already in use and with the industry flourishing under its own entrepreneurial momentum. "I would not disagree with that", he says. "I think that all governments tend to come into the act late in the day".

Other Government initiatives for IT '82 include the L-SAT telecommunications project for which the U.K. is to put up a third of the cost, amounting to £77 million; a major system for reading electricity meters remotely via the mains; the creation of a nationwide network of Microsystem Centres at which advice and training will be available to businessmen; an IT '82 stamp to be issued by the Post Office in September 1982 and additional support for computer-aided design, robotics, and fibre optics.

The Government has also recently announced that they will set up a network of IT Centres based on the successful Notting Dale Technology Centre, described in *Your Computer* last month. The Centre will aim to give unemployed young people training and work experience in microelectronics and computing skills.

IT '82 will end with a two-day conference and exhibition at the new Barbican Arts Centre in London on December 8 and 9 with international speakers and more than 1,000 delegates. ■



REVIEW

MORPHY V. CHAMPION

TWO MAJOR developments in the last year have changed the type of chess computer commercially available. The first is the widespread introduction of sensory boards which have eliminated the need to enter moves by pressing buttons. This greatly reduces operator errors, but means that players are no longer obliged to learn algebraic notation — something I had avoided for years but learned within four weeks of buying my first chess computer.

The second development is the incredible speed and strength of the best modern machines. New methods of targeting — using a superior evaluation function and keeping major pieces stored in a separate attack table — enable the machines to make the most efficient use of alpha-beta searching. This increases the speed of move-searching tremendously. Occasionally, however, the program makes an error, and takes as long as any of the older machines to make a move.

Strictly for experts

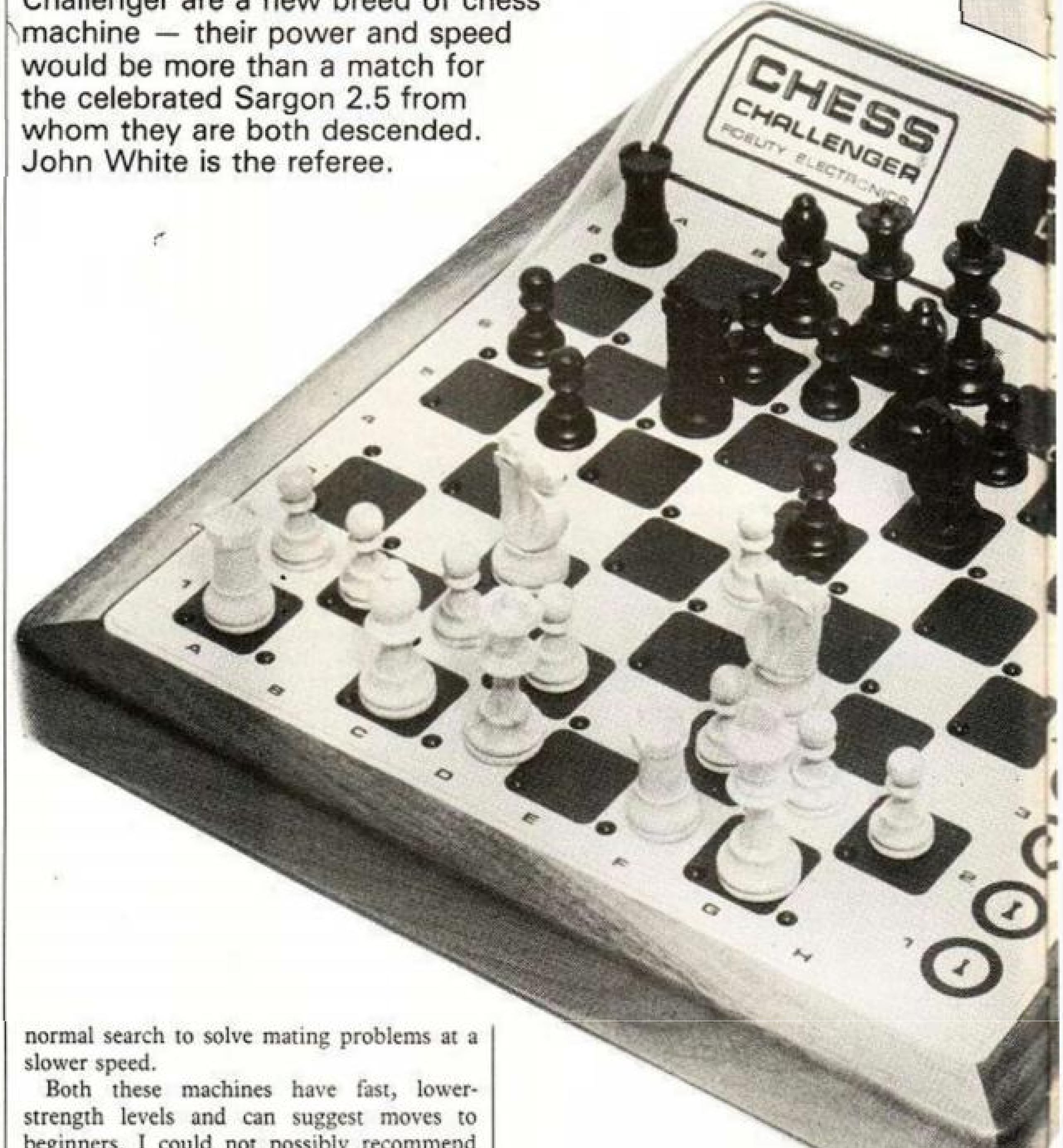
In the position shown in figure 1, the Morphy program playing at level 4 — average response time 2.25 minutes — took more than 23 minutes to find its move. The introduction of faster CPU chips has also accelerated play by a factor of about two. Double speed does not, however, imply double strength.

The strengths of the Morphy/Applied Concepts, March 1981 — and the Champion Sensory Challenger — Fidelty, October 1981 — are a great improvement on the earlier machines. As usual, wild claims have been made about their playing strengths. The manufacturers are more modest. Applied Concepts claims ratings of 1800-1900 — BCF 150-160 — while Fidelity's strength of 1771 is given extra credibility by its endorsement by the American Chess Federation. These ratings all apply to the top levels, but these involve excessive response periods.

The top normal playing levels — around two-three minutes per move — would achieve ratings of around BCF 130-140 against opponents not used to playing chess computers. With experience, any competent chess player can defeat a chess computer once he has determined its weaknesses. Ratings for chess computers are subject to considerable error. The machine gains by the fact that, unlike a human, it cannot make a simple blunder; on the other hand, it can never learn by its mistakes.

Targeting can also be carried to its extreme to solve chess problems of the "mate-in-three" type with fantastic speed. Champion Sensory Challenger has taken advantage of this with special mate-solving levels. Morphy does not have this facility and relies instead on its normal search to solve mating problems at a slower speed.

The Morphy and the Champion Sensory Challenger are a new breed of chess machine — their power and speed would be more than a match for the celebrated Sargon 2.5 from whom they are both descended. John White is the referee.



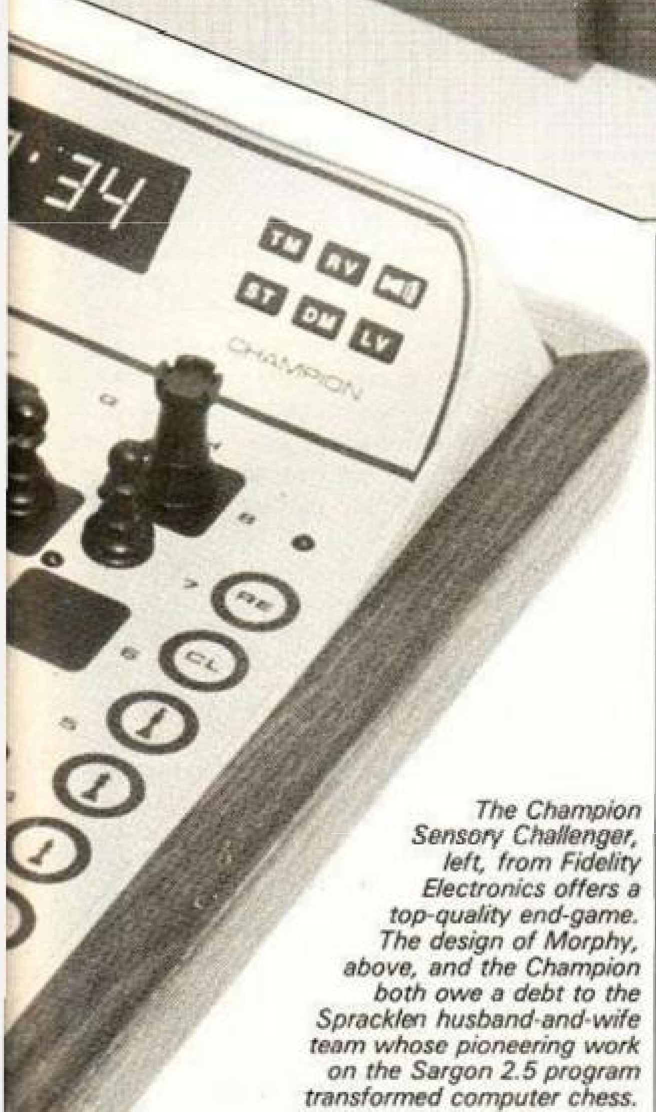
Both these machines have fast, lower-strength levels and can suggest moves to beginners. I could not possibly recommend either of these machines to the beginner — weaker machines are available at a fraction of the price. By the time a beginner could beat either of these monsters, not only would it be obsolete, but electricity probably would be as well.

Both machines can "think" while their opponent decides his move — they assess their response to the move they calculate their opponent will make. The machines can also prompt their opponent by revealing which move they think he should make. Again, both these machines offer random selection between moves of nearly equal merit — an important facility which makes all games different.

Morphy and Champion Sensory Challenger owe much of their design to the Spracklen husband-and-wife team. Both machines are, therefore, descendants of the famous Sargon 2.5 chess program and both are significantly stronger. The Spracklens now work for Fidelity.

It seems to have been the Spracklens who pioneered the new generation of super-fast chess computers with the Sargon 2.5. All programs they have written have been notoriously powerful. Kate Spracklen is a tournament player; Dan worked as a professional





The Champion Sensory Challenger, left, from Fidelity Electronics offers a top-quality end-game. The design of Morphy, above, and the Champion both owe a debt to the Spracklen husband-and-wife team whose pioneering work on the Sargon 2.5 program transformed computer chess.

computer programmer before devoting his time to the development of chess programs.

The Sargon 2.5 was manufactured by Applied Concepts and marketed by Chafitz. Chafitz has now withdrawn from the computer-chess market but Applied Concepts still manufactures and distributes chess machines. The Sargon 2.5 was a chess cartridge which plugged into a box containing most of the electronics. This limited the program to 8K of ROM. The box is now known as the Great Game Machine and Morphy is the new cartridge which plugs into it. The Great Game Machine lacks a touch-sensitive board — operation is by pressing buttons.

The improvements of Morphy on the Sargon 2.5 include faster play — its play at level 3 has an average response time of 15 seconds. That is reckoned to be equivalent to the 2.5's level 4 whose average response was two minutes. Morphy also has a better appreciation of positional play, better castling sense and an improved book-opening library. Space was made for this by deleting the unnecessary messages which the 2.5 used occasionally to flash, such as "You've been practising". Morphy also features an improved end-game which is entered only when the remaining level of material is sufficiently low.

Because Morphy is a module, it will be possible to replace it at a later date with improved modules. Meanwhile, owners of the 2.5 can buy the Morphy cartridge to update their Modular Game System, as the Great Game Machine used to be called. An important addition has been the introduction



Figure 1.

of two further chess modules which allow continuous play for one game of chess.

Although the book-opening library of Morphy is better than the 2.5's, it is still not very good. The King's Gambit, for example, runs only two moves deep in one of the main lines. The Grunfield-opening cartridge was made available in June 1981, and covers the openings in great depth. When the book cartridge is exhausted, it gives a signal. You then remove it and replace it with Morphy for the mid-game play. It is possible to select your opening, and to obtain prompts for the next move in the opening.

The end-game seems to start when the material count is less than about 25, counting a queen as 9, a rook as 5, and so on in the usual way. When this point has been reached, Morphy also gives a signal. The player can continue when Morphy switches in extra end-game routines. Alternatively, Morphy can be taken out and the Capablanca cartridge inserted for a powerful finish. Capablanca has been available since October 1981.

Morphy has nine playing levels, of which three — levels 4, 7 and 8 — provide the normal top playing strength. That is, the average response time does not exceed three minutes per move. Other levels provide for postal chess, faster games or beginners.

The programmers claim to have taken special care to take mobility into account with Morphy. This gives the program a surprising degree of strategic insight into positions. I have frequently found that my pieces have somehow become tied up while Morphy retains full mobility, and I have found it very difficult to free my position. This is a considerable and very impressive achievement by the designers. In addition, Morphy will sometimes even make positional sacrifices; for example, exchanging a bishop for one or two pawns on the weak enemy KB2 square.

Strategic weakness

On the other hand, it is curiously obtuse about sacrifices made against its own pawn formation, and I have often won games by this method. Another surprising strategic weakness is the ease with which the opponent can inflict isolated double pawns on Morphy. These become a terrible handicap in the end-game — if not earlier.

The tactical play of Morphy must not be scorned either. Although not so fast as Champion Sensory Challenger at devising combinations, it can easily see six or seven ply ahead in mid-game. It will, for example, sacrifice a bishop for three pawns in a carefully-worked combination involving an intermediate check, as I have learnt to my cost.

Although the average response times for Morphy to make its move are as stated by the manufacturer, times can vary widely. In games that are either very complicated, or very quiet, the program frequently overruns its stated tournament times, and would lose in a real competition. The program does not automatically adjust its time for thinking according to the time it has remaining.

When the end-game routines are called, Morphy slows noticeably. It is apparent that it can now see up to 10 ply ahead in some lines. Promotion of a pawn now becomes of paramount importance, and Morphy will make any sacrifice to delay arrival of an enemy pawn on the eighth rank, unnecessarily giving up several pieces — the horizon effect — to delay the fateful move.

The end-game has always been the weakest part of any chess computer's game. The play by Morphy is very impressive, and it is, I think, the first commercially-available computer which could win a simple king and rook versus king ending. It plays a bishop,

(continued on next page)

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knight and king versus king ending well, driving the king into a corner, but fails to realise that the corner must be of the same colour as the bishop for checkmate.

The king is used aggressively and accurately in the end-game — I always felt that the Sargon 2.5 king adopted a kamikaze approach, hurling itself into the fray. Only the pawns' positioning leaves something to be desired.

A considerable amount of theory has been amassed on computer chess end-games, and the Capablanca end-game cartridge reputedly uses look-up tables to find its moves. With 12K of ROM and 3K of RAM, it is claimed to be the only commercial chess program dedicated to playing the end-game. It will also recognise draws, under the three-move or repetition and 50-move rules.

Variable vocabulary

Sad to say, however, it still cannot win the king, bishop and knight ending against a king, and the difference in the beep tone between it and Morphy is disconcerting. Nevertheless, Capablanca is a useful addition to Morphy, and can look up to 15 ply ahead.

The Great Game Machine and Morphy cost around £295, but can sometimes be found at discount prices. The cartridge alone costs about £95, and Grunfield and Capablanca also cost about £95 so that the complete chess program will cost around £485. Grunfield, which consists essentially of look-up tables, seems to be overpriced when compared with Morphy which is the culmination of years of research.

Other cartridges available for the Great Game Machine include Borchek draughts at about £70, as well as several others. Borchek is one of the strongest commercially-available draughts programs. The Morphy program can also be found in the Morphy Encore machine which lacks the capability to change cartridges, but is otherwise the same as the Great Game Machine. It is available at the very reasonable price of £180.

Fidelity's Champion Sensory Challenger or CSC consists essentially of the older Sensory Voice Challenger with a new program. Thus, it offers the sensory board of its predecessor, 64 pre-programmed games against grandmasters, 64 different book openings, a real-time clock and a voice in one of four languages.

I thoroughly dislike the voice, and switched it off during most of the testing. The voice can have its volume or its vocabulary altered, or it can be replaced by a beep tone. The 64 games against grandmasters are certainly interesting, but they must consume a good deal of expensive ROM. I feel that the voice and these games should be offered as optional extras, with a reduction in the price of the main unit.

The sensory board is a delight to use, and is the same as those of the Sensory 8 and Sensory Voice machines. Fidelity also has the most enviable reputation for reliabililty, and some dealers are offering extended, two-year guarantees. The whole unit is built like a wood and plastic battleship — excellent. A printer, costing around £170, can also be used to provide a permanent record of the game.

Inside the machine, the previous Z-80 chip and program have been superseded by a Spracklen-designed program on a 6502 chip. Later models will bear the faster 6502A microprocessor. The CSC has performed very well in microcomputer chess tournaments, winning the 1980 World Microcomputer Chess Championship and the 1980 North American Microcomputer Chess Championship outright. The 6502A Elite version won the 1981 World Microcomputer Championship in Hamburg, West Germany.

As you might expect, the standard of play is outstanding and very fast — even by the standards set by the other machines. The style of play bears surprisingly little resemblance to Morphy, despite their common origin, and a few features are noticeably different.

For example, the older Sargon 2.5 was criticised for its propensity to exchange its bishops for opponent knights early in the game. Morphy, however, can hardly be induced to make this exchange, with important implications for play in, say, the Nimzowitsch defence. CSC retains the pattern of exchange of the 2.5. It is debatable which approach is more correct.

Other features of CSC's play include the fact that it is not so prone to suffering from doubled pawns as Morphy. However, it does retain the 2.5's curious habit of making a move, changing its mind, and moving back again in quiescent positions. Equally, in quiescent positions, it will sometimes make a peculiar king move — sometimes back towards the centre immediately after castling.

Stunning speed

The CSC does not consider mobility factors to nearly the same extent as Morphy, and it is easy to inflict a "bad bishop" or "bad knight" on it. Nevertheless, its power in combinations coupled with the speed with which it performs them makes it easy to see why it has done so well in computer tournaments where ability to play accurately is more important than the ability to form a plan. On the other hand, Philidor has also done well in tournaments precisely because it can form simple plans.

CSC makes automatic moves at once — those situations where only one move is legal — unlike virtually all other chess computers which spend a long time calculating the opponent response. Obviously, when this happens, CSC is unable to prompt the opponent. Simple, strong moves, such as captures, are also made at stunning speed.

CSC can be programmed to complete all its moves within certain time limits. It adjusts the speed of its response according to the time remaining, and can never lose on time. This important facility means that at corresponding time levels it is at a disadvantage with respect to Morphy, which will always calculate its moves to completion. This is a criticism of Morphy rather than of CSC.

There are eight levels available for normal play, with further levels for problem solving — which is particularly easy to set up on the sensory board — mating problems and postal chess. The eighth level takes an average of six minutes to make its move, while the sixth level takes only three minutes. CSC takes little more than a minute to find the correct move for figure 1 — this does not, of course, imply that it chose it for the same reason, and it gives a different prompt compared with Morphy's.

Useful for openings

The opening library of CSC is well varied and relatively deep in many of the main lines, leading the machine well into the middle game. Unusually, the book is accessible whether the human plays from the top or bottom of the board or as black or white. Unusually, too, the opponent can ask for a prompt for his next book move while the machine is still playing from the book. This is useful to teach openings.

Fidelity does not give much prominence to the quality of CSC's end-game. This is surely a mistake, since the end-game play is absolutely first class — the best that I have seen in a commercial chess machine. It plays a rook and pawn versus rook ending brilliantly, looking up to 10 ply ahead at the higher levels. It can give mate with a king and rook versus a king, but, like Morphy, drives the enemy king into the wrong corner with a bishop and knight.

The end-game play of grandmasters is well known to be the greatest difference between them and the rest of us, and their play has been studied for many years by psychologists and others in an attempt to find why. These attempts have largely been fruitless — grandmasters themselves admit that they do not know how they assess positions.

The end-game play of all Spracklen-designed programs is very strong, and it seems that they have managed to pin down the ingredients which make good end-game play. A book entitled *How to play the end-game in chess* by these two would make fascinating reading.

The Champion Sensory Challenger costs about £330 — and may be found at discount prices — and the board can also be used as a board between two human players when no illegal move will be accepted. It is disappointing to note that the program is not supplied on an interchangeable cartridge — particularly sad since this facility is available on the down-market Mini Sensory Challenger.

CONCLUSIONS

- Morphy and Champion Sensory Challenger justify their reputations as two of the most powerful chess computers on the market.
- Morphy is supplied on a cartridge which can be extended by contiguous play or by replacement at a later date with a superior version.
- CSC is faster and superior at playing mid-game combinations — at equal response times — for those who like a real battle, and plays a superior end-game.
- Morphy plays a more human style of chess, which a positional player will appreciate better.
- CSC is less expensive than the full Morphy-Grunfeld-Capablanca combination and has a sensory board and also the voice—if you like it.
- I can strongly recommend both machines. ■

MYSTERY AT THE HOUSE

No-one has ever left the House of Treasure alive to tell of the fortune it conceals. Now Chris Davison's adventure beckons to you.

THE TROUBLE WITH most mini Adventure games in Basic is that they tend to suffer from one or more of the following:

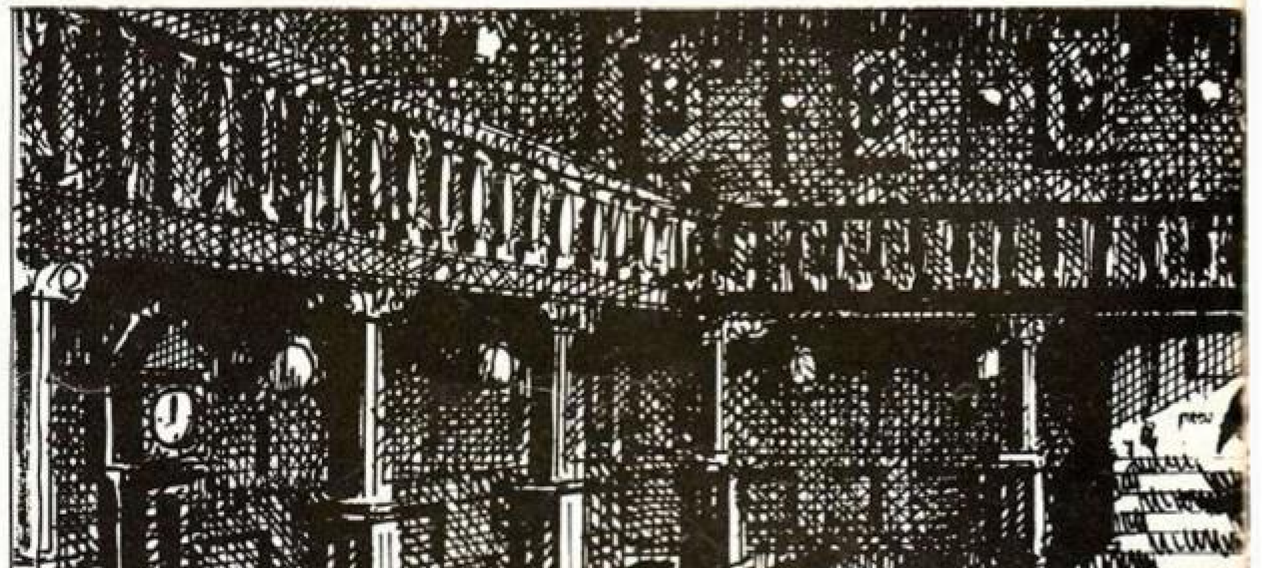
- You find monsters, kill them and collect treasure indefinitely.
- You can move only forwards and to the sides — one cannot retrace one's steps.
- The adventure lacks any aim, and if it does have one, it is the same each time.
- They are very difficult to amend without a great deal of fuss and wasted time.

In my mini Adventure, I hope to overcome most of these problems. Without divulging too many secrets, let me first explain the objects of the game.

You are at the entrance of a very old house which is rumoured to contain a huge hoard of treasure. However, no-one has ever left it alive to tell the tale. This adventure is not as simple as it looks and took me almost a month to solve. I have succeeded only once since then. Your score is kept throughout and is calculated on treasure, monsters, strength, time, keys, lamps and so on.

I will try to explain how to delete, expand or otherwise alter the program to suit your needs.

The progam is written in XTAL 2.2 Basic for the Sharp MZ-80K, and when run occupies about 14K — 13.2K to be exact. It should work with only minimal alterations on any micro running a Microsoft-type Basic. Graphics can be added very easily using a subroutine which is called from the description routine.



Routines

0000 — 0060	Dims, call various set-up routines
0070 — 0200	Actual program — calls all other routines
1000 — 1250	Set up house details
1300 — 1396	Set up treasure, monsters and other variables
1400 — 1470	Options
1500 — 1530	Output of descriptions
1600 — 1650	Your choice — e.g., north south
1700 — 1810	Move, calculate position of walls, etc.
1900 — 1930	Explore
2000 — 2050	Open
2100 — 2160	Stairs
2200 — 2260	Trap
2300 — 2380	Key
2400 — 2460	Lamp
2500 — 2540	Trigger
2600 — 2650	Cellar entrance
2700 — 2780	Door
2900 — 2970	Desk
3000 — 3040	Cupboard
3100 — 3150	Clock
3200 — 3240	Piano
3300 — 3350	Dead
3400 — 3450	Clue
3500 — 3586	Comblock etc.
4000 — 4195	Monsters
4200 — 4330	Status
5000 — 5060	Kidnapped
5100 — 5270	Treasure
6000 — 6060	Strength
7000 — 7270	Treasure or trap
8000 — 8200	Instructions

As you can see from the list of routines, it is very much a modular program, and as such is very simple to alter to suit your needs. If you wished to change the piano for a wardrobe, you place your new routine at 3200-3240.

If you wish to plot the graphics for a wardrobe, you could do it within the routine or call a new routine to do so. This new routine could then be used as the base for all your other graphics routines.

Those with computers of limited storage could use this idea to fit the program into their available memory. The routines are reasonably self-explanatory; nevertheless, I have provided a list of variables and the details of the two main arrays.

Variables

M(, ,)	— House details
T(, ,)	— Treasure details
D$( )	— Descriptions
MM$( )	— Monsters
A( ),B( )	— Location of clues
TI$	— Time
CL$	— Clue in string form
CH$	— Your clue guess
A$	— General
A,B,C,D,E,F	— Numeric general workhorses
XX , YY	— Cellar exit
X , Y	— Your location
Z	— Your level — floor
ST	— Strength
L	— Lamp
K	— Key
MK	— Monsters killed
SC	— Score
CC	— Clues collected
MO	— Monster flag
TF	— Treasure flag

Both M( ) and T( ) have numeric terms which represent some description. These are used to access the routines as well as to calculate the walls, etc.

What the codes mean:

	M( )	T( )
0	External wall	N/A
1	Hall	Trap
2	Locked door	Key
3	Open door	Lamp
4	Staircase	Trigger
5	Desk	Cellar entrance
6	Cupboard	Clue
7	Clock	Comblock
8	Piano	Treasure
9	Chair	N/A
10	Statue	N/A
11	Fireplace	N/A
12	Bookcase	N/A

OF TREASURE



Each of the three main floors — expanded to as many as you like by re-dimensioning and incrementing the For-Next loops in the set-up routines — has a standard hall layout:

	X	H	X		
X		H		X	X
H	H	H	H	H	H
X		H		X	X
	X	H	X		
	X	H	X		

The data string gives the computer a random choice of places to put the doors which are marked with crosses in the diagram. These positions vary on each floor.

You may have noticed that there are no walls in M(,,). They are calculated by the fact that if you are in a hall, you cannot see anything where M(,,) exceeds three — clock, cupboard, etc. The same idea holds true when you are in a room — that is, you cannot see the hall. The treasure is distributed randomly. However, its position may depend on what is in the corresponding M(,,) array.

If you wish to add a new routine, there are one or two points you may wish to know: the routines are called by the On-Gosub at line 2010; should you wish to add a new treasure routine, there is a similar On-Gosub for treasure at line 1920.

```
0 REM ********************************
1 REM **                            **
2 REM **       TREASURE HOUSE       **
3 REM **             by             **
4 REM **         C.J.DAVISON        **
5 REM **                            **
6 REM **     in XTAL 2.2 BASIC      **
7 REM ********************************
8 CLS
9 GOSUB 8000
10 REM          HOUSE MK I
20 DIM M(7,7,3),T(7,7,3),D$(12),MM$(30),A(4),B(4)
30 RESTORE
40 GOSUB 1000
50 GOSUB 1300
55 PRINT "▮HIT ANY KEY TO PLAY":J=INCH
56 TI$="000000"
60 CLS
70 GOSUB 1400
80 GOSUB 1600
90 IF INT(1+6*RND(8))=4 THEN GOSUB 4000
100 IF ST<1 THEN GOSUB  6000
110 IF Z=0 AND X=XX AND Y=YY THEN GOSUB 5000
200 GOTO 70
1000 REM          SET UP HOUSE DETAILS
1010 FOR B=1 TO 3:FOR A=1 TO 6
1020 M(A,3,B)=1:M(3,A,B)=1
1030 NEXT A,B
1040 A=INT(1+6*RND(7))
1050 FOR B=1 TO 3:M(A,3,B)=4:NEXT B
1060 DATA 2,2,1,1,2,3,4,1,5,2,6,2,3,1,4,2,5,2,6,1,4,5,4,6,5,4,6,4,9
1070 FOR F=1 TO 3:RESTORE
1080 READ A:IF A=9 THEN 1120
1090 B=INT(1+A*RND(9))
1100 FOR C=1 TO B:READ D,E:NEXT C:M(D,E,F)=INT(2+2*RND(5))
1110 IF B=A THEN 1080 ELSE READ D,E:B=B+1:GOTO 1110
1120 NEXT F
1130 FOR C=0 TO 3:FOR A=1 TO 6:FOR B=1 TO 6
1140 IF M(B,A,C)<>0 THEN 1180
1150 M(B,A,C)=INT(5+8*RND(3))
1180 NEXT B,A,C
1190 FOR D=1 TO 2
1200 A=INT(1+6*RND(7))
1210 B=INT(1+6*RND(7))
1220 C=INT(1+3*RND(5))
1230 IF M(A,B,C)<5 OR M(A,B,C)>8 THEN 1200
1240 IF D=1 THEN T(A,B,1)=5
1242 IF D=2 THEN T(A,B,C)=7
1245 NEXT D
1250 RETURN
1300 REM               OTHER BITS
1310 K=0:X=3:Y=6:Z=1:L=0:TF=0
1320 DATA HALL,DOOR,DOOR,STAIRCASE,DESK,CUPBOARD
1330 DATA CLOCK,PIANO,CHAIR,STATUE,FIREPLACE,BOOKCASE
1340 FOR A=1 TO 12:READ D$(A):NEXT A
1350 MO=0:ST=100:CL$=STR$(INT(1000+8999*RND(7))):CC=1
1360 FOR A=1 TO 6:FOR B=1 TO 6
1370 M(A,B,0)=INT(5+8*RND(8))
1380 NEXT B,A
1381 DATA TROLL,GHOST,IMP,BAT,GIANT,ZOMBIE,GROCKLE,HOUND,DEVIL,KOBOLD,RAT,XORN
1382 DATA GOBLIN,ORCUS,HYDRA,SERPENT,BASILISK,PHEONIX,MEDUSA,SALAMANDER
1383 DATA GARGOYLE,BEHOLDER,JUBILEX,GOLEM,VAMPIRE,HELL HOUND,GUARDIAN,ORC,ELF
1384 FOR T=1 TO 29:READMM$(T):NEXT
1385 XX=INT(1+6*RND(8)):YY=INT(1+7*RND(7))
1386 FOR A=1 TO 6:FOR B=1 TO 6:FOR C=0 TO 3:IF T(A,B,C)<>0 THEN 1388
1387 IF INT(1+7*RND(7))=5 THEN T(A,B,C)=8
1388 IF INT(1+4*RND(7))=2 AND T(A,B,C)=0 THEN T(A,B,C)=INT(1+4*RND(8))
1389 NEXT C,B,A
1390 FOR A=1 TO 4
1391 B=INT(1+6*RND(8)):C=INT(1+6*RND(9)):D=INT(1+3*RND(6))
1392 IF T(B,C,D)<>0 OR M(B,C,D)<5 OR M(B,C,D)>8 THEN 1391
1393 T(B,C,D)=6
1394 NEXT A
1396 RETURN
1400 REM               OPTIONS
1401 PRINT
1410 M=M(X,Y-1,Z):A$="North "
1420 GOSUB 1500
1430 M=M(X-1,Y,Z):A$="West"
1440 GOSUB 1500
1450 M=M(X+1,Y,Z):A$="East"
1460 GOSUB 1500
1462 M=M(X,Y,Z):A$="By the side "
1464 GOSUB 1500
```

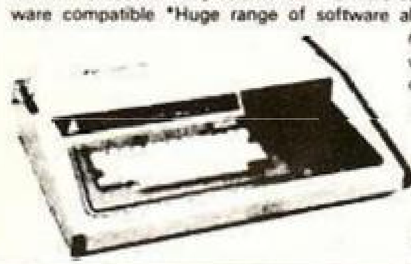
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```
1466 M=M(X,Y+1,Z):A$="South "
1468 GOSUB 1500
1470 RETURN
1500 REM                DESCRIPTIONS
1510 IF ((M(X,Y,Z)=1 OR M(X,Y,Z)=4)AND M>4) OR M=0 THEN RETURN
1515 IF (M(X,Y,Z)>4 OR M(X,Y,Z)=3) AND (M<5 AND M<>3) THEN RETURN
1516 IF M(X,Y,Z)=2 AND M>4 THEN RETURN
1520 PRINT A$;" of you is a ",D$(M)
1530 RETURN
1600 REM                YOUR CHOICE
1610 PRINT "■(1)move  (2)explore  (3)open  (4)status"
1625 PRINT
1630 A=INCH-48:IF A<1 OR A>3 THEN GOSUB4200:GOTO 1600
1640 ON A GOSUB 1700,1900,2000
1650 RETURN
1700 REM                MOVE
1710 PRINT "(1)north  (2)south   (3)west   (4)east"
1730 A=INCH-48:IF A<1 OR A>4 THEN 1730
1740 IF A=1 THEN C=-1:B=0
1750 IF A=2 THEN C=+1:B=0
1760 IF A=3 THEN C=0:B=-1
1770 IF A=4 THEN C=0:B=+1
1780 M=M(X+B,Y+C,Z)
1781 IF M=0 THEN RETURN
1785 IF M(X,Y,Z)=3 THEN GOSUB 2700:GOTO 1800
1786 IF M(X,Y,Z)=2THEN GOSUB 2700:IF M>4 THEN RETURN
1790 IF ((M(X,Y,Z)=1 OR M(X,Y,Z)=4)AND M>4) OR M=0 THEN RETURN
1791 IF (M(X,Y,Z)>4 OR M(X,Y,Z)=3) AND (M<5 AND M<>3) THEN RETURN
1792 IF M(X,Y,Z)=2 AND M>4 THEN RETURN
1800 X=X+B:Y=Y+C
1810 RETURN
1900 REM                EXPLORE
1910 IF M(X,Y,Z)=4 THEN GOSUB 2100:GOTO 1930
1920 ON T(X,Y,Z) GOSUB 2200,2300,2400,2500,2600,1250,1250,5100
1930 RETURN
2000 REM                OPEN
2010 ON M(X,Y,Z) GOSUB 1930,2700,2700,1930,2900,3000,3100,3200
2020 IF M(X,Y,Z)>1 AND M(X,Y,Z)<9 AND M(X,Y,Z)<>4 THEN 2050
2030 PRINT "I've never opened a ";D$(M(X,Y,Z))
2040 PRINT "and i don't intend to start now!"
2050 RETURN
2100 REM                STAIRS
2110 PRINT "Climb up or down?"
2120 PRINT "        1 or   2"
2130 A=INCH-48:IF A<1 OR A>2 THEN 2130
2140 IF (A=1 AND Z=3)OR(A=2 AND Z=1) THEN PRINT "you can't!":GOTO 2130
2150 IF A=1 THEN Z=Z+1:ELSE Z=Z-1
2160 RETURN
2200 REM                TRAP
2210 PRINT "CONGATULATIONS,you've just found a trap"
2220 A=INT(20+30*RND(7)):PRINT A;"of you strength units are used up"
2230 ST=ST-A
2240 PRINT "You are lucky,you are still alive,but    only just!"
2250 PRINT "Tread more carefully in future...."
2260 RETURN
2300 REM                KEY
2310 PRINT "You have just found a key,however it may  well be boobytrapped!"
2320 PRINT "■Do you want it?":A=INCH
2330 IF A<>89 THEN PRINT "NO..ok suit yourself":RETURN
2340 IF INT(1+9*RND(7))<>3 THEN PRINT"The key's yours":K=1:T(X,Y,Z)=0:RETURN
2350 PRINT "      ****BOOM****"
2360 PRINT "■      BOOBYTRAPPED!"
2370 GOSUB 2220
2380 RETURN
2400 REM                LAMP
2410 PRINT "Ah ha,one lamp yours for the takeing"
2420 PRINT "Do you want it?":A=INCH
2430 IF A<>89 THEN PRINT "NO!":RETURN
2440 IF INT(1+9*RND(8))<>7 THEN L=1:PRINT"The lamp is yours":T(X,Y,Z)=0:RETURN
2450 PRINT "Oh dear this lamp wasn't for sale! you've got trouble...."
2460 GOSUB 2500:RETURN
2500 REM                TRIGGER
2505 IF MO=1 THEN RETURN
2510 PRINT "WELL DONE.......IDIOT"
2520 PRINT "you've just disturbed all the 'orrible  little bugs!!!!"
2530 PRINT "Belive me your in for fun now!":MO=1
2540 RETURN
2600 REM                CELLAR ENTRANCE
2605 IF Z<>1 THEN RETURN
2610 PRINT "Well well well look what you've found"
2611 PRINT "Yes the cellar entrance!"
2615 PRINT "DO YOU WANT TO GO IN?":A=INCH
2620 IF A<>89 THEN PRINT "OK":RETURN
2630 IF L=0 THEN PRINT "Tough,you'll need a lamp!":RETURN
2640 Z=0:PRINT "Good luck":GOSUB 2530
2650 RETURN
2700 REM                DOOR
2710 IF M(X,Y,Z)=3 THEN PRINT "ok the door is open":RETURN
2720 PRINT "the door is locked"
2730 IF K<>1 THEN PRINT "you will need a key to open it":RETURN
2740 PRINT "do you wish to unlock it?":A=INCH
2750 IF A<>89 THEN PRINT "suit yourself!":RETURN
2760 M(X,Y,Z)=3:PRINT "the door is open"
2770 IF INT(1+9*RND(7))=3 THEN PRINT "the key is jammed in the lock":K=0
2780 RETURN
2900 REM                DESK
2910 IF INT(1+5*RND(8))<>2 THEN 2950
2920 PRINT "The desk is jammed,do you wish to force  it?":A=INCH
2930 IF A<>89 THEN RETURN
2940 ST=ST-INT(1+10*RND(8)):PRINT "UGGGGH, opened it!"
2950 IF T(X,Y,Z)=0 THEN PRINT "waste of time,it's empty":RETURN
2960 ON T(X,Y,Z) GOSUB 1250,2300,2400,2500,2600, 3400,3500
2970 RETURN
3000 REM                CUPBOARD
3010 IF L=0 THEN PRINT "It's too dark to see,you need a lamp":RETURN
3020 IF INT(1+9*RND(2))=4 THEN PRINT "Your lamps blown out!":L=0:RETURN
3030 GOSUB 2950
3040 RETURN
3100 REM                CLOCK
3110 PRINT "Creeeeeeek,the door is stiff and this   weakens you"
3120 ST=ST-INT(1+5*RND(9))
3130 IF INT(1+9*RND(8))=4 THEN GOSUB 4000
3140 GOSUB 2950
3150 RETURN
3200 REM                PIANO
3210 PRINT "Congratulations,you have found a KEY"
3220 IF T(X,Y,Z)<>2 THEN PRINT "But then again most pianos have keys!!!"
3230 GOSUB 2950
3240 RETURN
3300 REM                END
3305 PRINT
3310 PRINT "HA HA...THE HOUSE HAS CLAIMED ANOTHER    BODY!!!"
3320 PRINT "THE TREASURE LIES HIDDEN,YOU HAVE FAILED"
3330 PRINT "YOUR FINAL STATUS IS.................."
3340 GOSUB 4220
3350 GOTO 4309
3400 REM                CLUE
3410 PRINT "YOU HAVE FOUND A CLUE..."
3420 CC=CC+1:IF CC=5 THEN PRINT "THE LAST ONE YOU'LL NEED!"
3430 PRINT "THE NUMBER IS....";MID$(CL$,CC,1);" REMEMBER IT "
3440 T(X,Y,Z)=0
3450 RETURN
3500 REM                COMBLOCK
3510 PRINT "YOU HAVE FOUND THE PLACE TO DEPOSIT YOUR  CLUES"
3520 PRINT "ARE YOU READY TO TRY ?":A=INCH
3530 IF A<>89 THEN RETURN
3540 PRINT "■  ENTER THE CODE,AND AFTER CHECKING     PRESS (CR)"
3550 INPUT "*****";CH$:CH$=" "+CH$
3560 IF CH$<>CL$ THEN PRINT "WRONG....YOU HAVE FAILED..NOW DIE":GOTO 3300
3570 PRINT "■■■BRILLIANT YOU HAVE DONE WELL MY FRIEND"
3580 TF=1
3581 GOSUB 7000
3585 GOSUB 4200
3586 GOTO 4309
4000 REM                MONSTERS
4010 IF MO=0 THEN RETURN
4020 A=INT(1+29*RND(8)):B=A+INT(1+4*RND(8))
4030 PRINT "■ you have just been confronted by a "
4040 PRINT MM$(A):PRINT "■What do you wish to do?"
4050 PRINT "(1) Retreat  (2) Attack  (3) Gamble"
4060 C=INCH-48:IF C<1 OR C>3 THEN 4050
4070 ON C GOTO 4080,4120,4160
4080 IF INT(1+3*RND(8))<>2 THEN PRINT "Escaped":RETURN
4090 PRINT "a ";MM$(A);" does not like chickens"
4100 PRINT "he attacks,good luck"
4120 PRINT "The ";MM$(A);" has ";B;"hit points"
4125 PRINT "■What's your punch factor";:U=INCH-48:IF U<1 OR U>9 THEN 4125
4126 PRINT
4130 ST=ST-U
4135 U=U*INT(1+5*RND(7)):B=B-U
4140 PRINT "Your punch leaves the ";MM$(A);" only";B
4145 PRINT "strength units!"
4150 C=INT(1+10*RND(8))
4152 B=B-C:IF B<1 THEN ST=ST-B:PRINT"you win..":MK=MK+1:RETURN
4154 ST=ST-C*2:PRINT "his hit leaves you with";ST;"points"
4156 IF ST<1 THEN RETURN:ELSE 4125
4160 A=INT(1+20*RND(6)):PRINT A;"Hit points are at stake"
4170 PRINT "Choose a number between 1 and ";20-A:INPUT B
4180 IF B=INT(1+(20-A)*RND(8)) THEN ST=ST+A:PRINT "YOU WIN....":RETURN
4190 PRINT "HA HA YOU LOSE":ST=ST-A
4195 RETURN
4200 REM                STATUS
4210 PRINT "■■YOUR CURRENT STATUS IS.............."
4215 PRINT"■■"
4220 PRINT "STRENGTH............";ST
4230 PRINT "MONSTERS KILLED.....";MK
4235 PRINT  "TREASURE.............";TR
4240 PRINT "KEY..................";K
4250 PRINT "LAMP.................";L
4260 PRINT "CLUES................";CC-1
4270 PRINT "LEVEL................";Z
4280 PRINT "COORDINATES.........";X;Y
4290 PRINT"TIME................. ";LEFT$(TI$,2);":";MID$(TI$,3,2);":";RIGHT$(TI$,
2)
4300 SC=MK*100+TR+10*(K+L)+10*ST-VAL(LEFT$(TI$,4))
4301 IF CC=5 THEN SC=SC*2
4302 IF TF=1 THEN SC=SC*2
4303 PRINT "■■YOUR SCORE IS **";SC;"**"
4305 RETURN
4309 PRINT "■■DO YOU WANT ANOTHER GO?";
4310 A=INCH:IF A=89 THEN RUN
4320 CLS
4330 END
5000 REM                KIDNAPPED
5010 PRINT "wooooooooooosh you've just found a travel agent!"
5020 PRINT "And you have been kidnapped and released  somewhere,but where?"
5030 X=INT(1+6*RND(8))
5040 Y=INT(1+6*RND(8))
5050 Z=INT(1+3*RND(7))
5060 RETURN
5100 REM                TREASURE
5110 A=INT(1+900*RND(9))
5120 PRINT "You have found";A;"pieces of gold"
5130 PRINT "Do you want them?":B=INCH
5140 IF B<>89 THEN RETURN
5150 TR=TR+A:ST=ST-INT(A/40)
5155 T(X,Y,Z)=0
5160 IF INT(1+9*RND(8))<>2 THEN RETURN
5165 PRINT "■You have also found:"
5170 A=INT(1+9*RND(8))
5180 IF A=1 THEN PRINT "a sword":ST=ST+INT(1+20*RND(7))
5190 IF A=2 THEN PRINT "bad luck!":MO=1
5200 IF A=3 THEN PRINT "a potion":ST=ST+INT(1+20*RND(8))-5
5210 IF A=4 THEN PRINT "an axe":ST=ST+7
5220 IF A=5 THEN PRINT "a lamp":L=1
5230 IF A=6 THEN PRINT "a key":K=1
5240 IF A=7 THEN PRINT "a time warp":TI$="000000"
5250 IF A=8 THEN PRINT "a nugget":TR=TR+INT(1+800*RND(8))
5260 IF A=9 THEN PRINT "a good luck charm":MO=0:ST=ST+10
5270 GOTO 5160
6000 REM                STRENGTH
6001 IF TR<30 THEN GOTO 3300
6002 PRINT "■■■■■"
6010 PRINT "HMMM you seem to be out of energy"
6015 PRINT "a grand score of";ST;"you need help!"
6016 PRINT "Since you have";TR;"items of treasure"
6017 PRINT "I feel i do a deal with you"
6020 A=INT(9+20*RND(8)):A=INT(TR/A)
6030 PRINT "I'll sell you one unit of energy for    every";A
6040 PRINT "pieces of treasure you give me...OK":B=INCH
6050 IF B=89 THEN ST=ST+INT(TR/A):TR=TR-A*INT(TR/A):RETURN
6060 IF INT(1+4*RND(8))=3 THEN PRINT "*FOOL*":GOTO 3300:ELSE 6020
7000 REM                BOOBYTRAP
7010 PRINT "■■■The previous owner of the treasure made"
7020 PRINT "sure that his secret would remain hidden"
7030 PRINT "■for a long time,he also gave the finder"
7040 PRINT "one final test,if you win..the treasure"
7050 PRINT "is yours....if you lose DEATH"
7060 PRINT "do you want to take the chance":A=INCH
7070 IF A<>89 THEN PRINT "OK..YOU HAVE DONE WELL":RETURN
7080 PRINT "■■■GOOD LUCK"
7090 PRINT "■■The chest has a lock on it"
7100 PRINT "To open it you must crack the code HIT  <CR> TO CONTINUE":A=INCH
7110 FOR X=1 TO 4:A(X)=INT(1+9*RND(8)):NEXT X
7120 FORX=1TO4:FORY=1 TO 4:IF X=Y THEN 7130
7125 IF A(X)=A(Y) THEN U=1
7130 NEXT Y,X:IF U=1 THEN U=0:GOTO 7110
7140 PRINT "3 point will be give if you choose right number in right place"
7150 PRINT "1  point for right number wrong place"
7155 S=0
7160 PRINT "■■ok type in your guess"
7170 FOR X=1 TO 4:B(X)=INCH-48:NEXT X
7180 FOR X=1 TO 4:IF B(X)=A(X)THEN S=S+3
7182 NEXT X
7190 FOR X=1 TO 4:FOR Y=1 TO 4
7200 IF X=Y THEN 7220
7210 IF B(Y)=A(X) THEN S=S+1:CALL 62
7220 NEXT Y,X
7230 FOR X=1 TO 4:PRINT B(X);:NEXT
7240 PRINT "**";S;"**"
7250 IF S=12 THEN PRINT "**ALL DONE**":TR=TR+INT(9999+99999*RND(8)):RETURN
7260 IF INT(1+10*RND(8))=4 THEN PRINT "TIMES UP":GOTO 3300
7270 S=0:GOTO 7170
8000 REM                INSTRUCTIONS
8001 PRINT "■■              TREASURE HOUSE"
8002 PRINT "
8003 PRINT "■■"
8010 PRINT "You are in a large old house"
8020 PRINT "When the old man who lived there died"
8030 PRINT "he hid all his worldly goods in the "
8040 PRINT "house.He also hid a hoard of treasure     (valued at £2M!)"
8050 PRINT "     To find this treasure you must find various clues and,more"
8060 PRINT "importantly,the place to put them..."
8070 PRINT " BE WARNED,he also left traps for the      unwary,so go carefully"
8080 PRINT "also,things may not always be as they"
8090 PRINT "seem.■■■■GO CAREFULLY MY FRIEND,AND GOOD LUCK"
8100 RETURN
8200 REM ***********THE-END************
```

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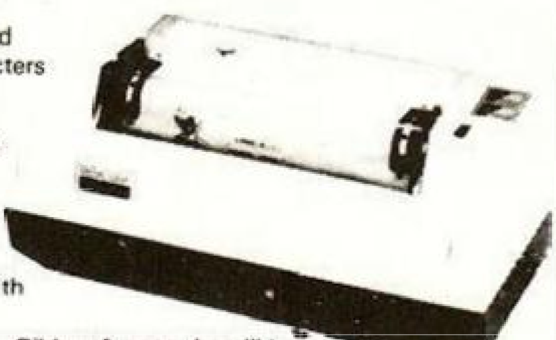


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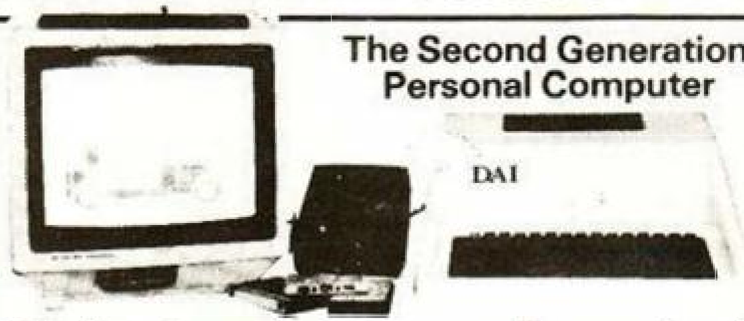
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IN MY PREVIOUS education piece, December, 1981, I tried to set out the different ways in which the computer can help the task of the teacher. I think it is worth reminding ourselves of the main categories of educational computing:

- Awareness: the aim is to maximise children's and adults' familiarity with computers and their uses. Simple programs can model many of those applications.
- Computer studies: work with the hardware as the apparatus of formal examination-orientated computer-science teaching.
- Computer-assisted learning (CAL): in which computer power is one of the many resources available for its effective teaching in most schools.

Figure 1. The questions displayed by program 1 and, below, the response to a wrong answer.

```
TYPE YOUR NUMBER BY YOUR ANSWER.

WHICH COMPLETES THE SENTENCE?

A.  OHMS LAW DEALS WITH
 1  CONDUCTORS
 2  INSULATORS
 3  SEMI-CONDUCTORS
 4  METALS.


L
```

```
NO

OHMS LAW DEALS WITH METAL.
```

```
                    OHMS LAW

   FIRST STATED IN 1840, THIS MAJOR LAW OF PHYSICS IS
CONCERNED WITH ELECTRIC CURRENTS IN PURE METALS.  WE
CALL THESE OHMIC CONDUCTORS.

THE LAW RELATES THE CURRENT IN A METAL SAMPLE TO THE VOLTAGE
BETWEEN ITS ENDS.

   HERE IS THE LAW

THE CURRENT IN A METAL SAMPLE AT CONSTANT TEMPERATURE IS PROPORTIONAL
TO THE VOLTAGE BETWEEN ITS ENDS.

PRESS N/L TO GO ON.

"L"
```

Figure 2. Improved display in response to a correct answer.

Figure 3. Output from program 2 to reinforce a correct answer and help pupils who guessed.

- Administration: with the computer aiding the general running of a school as in the case of any other business. Special packages are being developed.
- Data capture and process control: again, helping, as in any other business, with equipment interfacing.

What is also significant is that many people are buying micros for their homes with the main aim of helping their children with school work.

I think it is important to state that I do not believe that good teaching software can be written by any one individual. The ideal approach is to have a two-person team — a good programmer, expert with the micro in question, and a good teacher, expert in the subject in question.

Much educational software advertised is prepared by individuals rushing into a potential ground-floor gold-mine without those two different types of expertise.

The listings in this article are in ZX-81 Basic. Note that underlined material means inverse display. Although attractively laid out on the screen, a program made up of pages like those in program 1 is not a very helpful teacher. It is slightly better than a crude test which would simply count the correct answers to give a final score. At least it indicates whether the response is correct or not, and gives the correct answer. We would call a program like this a drill. It would be of use mainly in revision.

```
YES
OHMS LAW DEALS WITH METALS.

   THE LAW RELATES THE CURRENT
IN A METAL SAMPLE TO THE VOLTAGE
BETWEEN ITS ENDS.

   AN INSULATOR DOES NOT PASS
CURRENT.  OHMS LAW CAN SAY
NOTHING ABOUT INSULATORS THEN.

   THE BEHAVIOUR OF SO-CALLED
SEMI-CONDUCTORS CAN BE COMPLEX.
WE SHALL DEAL WITH THEM LATER.

THERE ARE OTHER CONDUCTORS
THAN METALS.  SOLUTIONS OF SOME
COMPOUNDS ARE AN EXAMPLE.  THESE
DO NOT ALL OBEY OHMS LAW.

OHMS LAW DEALS WITH METALS.
PRESS N/L TO GO ON.

"L"
```

A true CAL program has the following additional features:

- Some text is presented for study before each self-assessment question.
- Correct answers are reinforced more strongly than in the program 1 — at least explaining why the wrong answers are wrong.
- Incorrect responses lead to more help — a fuller explanation of the relevant part of the original text — and the user would have another attempt at the question.

Figure 2 shows a possible first page of such a teaching program, designed to meet the first of these three requirements. How, then, can be reinforce correct answer more strongly than before? The need for this should be obvious — a person using the program may

(continued on next page)

Program 1.

```
  01  LET A$ = " OHMS LAW "
 110  GOSUB 1000
 120  PRINT AT 10, 0; "A.   OHMS LAW DEALS WITH"
 130  PRINT "    1    CONDUCTORS"
 140  PRINT "    2    INSULATORS"
 150  PRINT "    3    SEMI-CONDUCTORS"
 160  PRINT "    4    METALS"
 170  GOSUB 1050
 180  IF A = 4 THEN PRINT "YES"
 190  IF A<>4 THEN PRINT "NO"
 200  PRINT "OHMS LAW DEALS WITH METALS."
 210  GOSUB 1100
 250  (start next question)
 999  STOP
1000  REM HEADINGS
1010  PRINT TAB 11; A$,,,
1020  PRINT "TYPE THE NUMBER BY THE ANSWER",,,
1030  PRINT "WHICH COMPLETES THE SENTENCE?"
1040  RETURN
1050  REM RESPONSE
1060  INPUT A
1070  IF A<1 OR A> 4 THEN GOTO 1060
1080  CLS
1090  RETURN
1100  REM CONTINUE
1110  PRINT AT 21, 0; "PRESS N/L  TO GO ON."
1120  INPUT A$
1130  CLS
1140  RETURN
```

(continued from previous page)

have guessed the answer, used a pin to select the response, or made a typing slip. Even if he knew the answer, he needs real reinforcement and perhaps extra information, too.

Figure 3 shows a more suitable response to a correct answer. As you can see from program 1, in our first version, a correct response would have been followed only by

YES

OHMS LAW DEALS WITH METALS.

. . .

PRESS N/L TO GO ON.

A display such as figure 3 following a correct response

- Strongly reinforces that correct response, whatever caused it
- Gives help to those who guessed or mis-typed
- Gives extra information to those interested.

Of course such a display would help those who gave any wrong response. Indeed, the way I have written the program so far, with figure 3 derived from lines 202 to 207, those people would obtain the same display, but with "No" at the top rather than "Yes". We could certainly use it for them, adding a line 208 to return to the question on the previous page.

In this case, that approach to meeting the third requirement of CAL would not be too bad. Of course, it also saves a good deal of memory and programming time. All the same, a good teacher — and thus a good teaching program — should give a different, detailed follow-up to each incorrect response, before giving the user another go. To the programmer, the problem that follows this requirement is one of cost — cost in memory space.

A significant way of saving memory in a case like this is to assign to string variables any lengthy messages which may appear more than once. It is more efficient to have three lines like

LET A$ = "message" – PRINT A$ – PRINT A$

than two like

PRINT "message"

In our example program, it is likely that Ohm's law will need to be displayed on a number of occasions. Putting it in a string variable will lead to an enormous saving in time and memory. Program 2 includes all these points.

To summarise, the difference between software in the form of program 1 and program 2 is the difference between a casual teacher and a concerned one.

A good teacher does more than say "right" or "wrong" to the answer to a question. He will reinforce correct answers and check why they were given. He will give extra information for wrong answers and ask the questions again.

A good CAL program must do the same. To write such a program is not easy, but the result will do the job well.

There are other things a good teacher does which have not been demonstrated in this program. In particular the teacher gives information by pictorial as well as verbal means. A program should make much use of graphics to convey concepts and explanations.

Program 2.

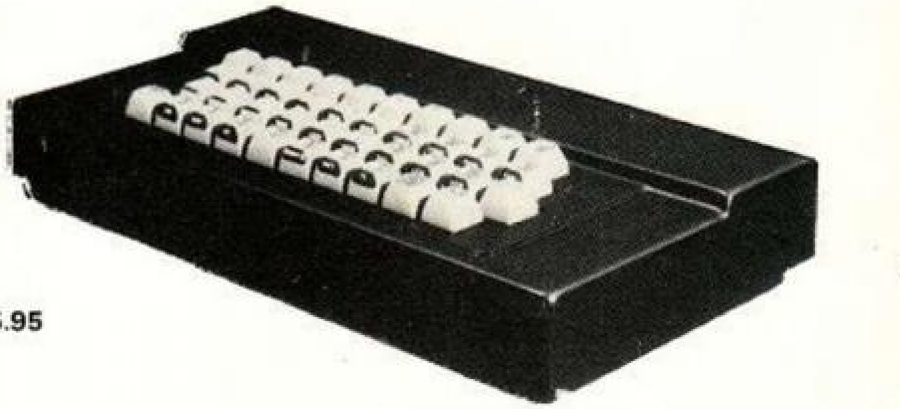
```
   1 LET A$=" OHMS LAW "
   2 LET B$=" OHMS LAW DEALS WITH METALS."
   3 LET C$=" THE CURRENT IN A METAL SAMPLE
     AT CONSTANT TEMPERATURE IS PROPORTIONAL
     TO THE VOLTAGE BETWEEN ITS ENDS."
   4 LET D$=" THE LAW RELATES THE CURRENT IN
     A METAL SAMPLE TO THE VOLTAGE BETWEEN ITS
     ENDS."
   5 LET E$=" AN INSULATOR DOES NOT PASS CURRENT.
     OHMS LAW CAN SAY NOTHING ABOUT INSULATORS THEN.
   6 LET F$=" THE BEHAVIOUR OF SO-CALLED SEMI-CONDUCTORS
     CAN BE COMPLEX.  WE SHALL DEAL WITH THEM LATER."
   7 LET G$=" THERE ARE OTHER CONDUCTORS THAN METALS.
     SOLUTIONS OF SOME COMPOUNDS ARE AN EXAMPLE. THESE
     DO NOT ALL OBEY OHMS LAW."
   8 LET H$=" HERE IS OHMS LAW AGAIN:"
  20 PRINT TAB 11;A$
  30 PRINT  ,," FIRST STATED IN 1840, THIS MAJOR LAW OF
     PHYSICS IS CONCERNED WITH ELECTRIC CURRENTS INPURE
     METALS.  WE CALL THESE  OHMIC CONDUCTORS."
  40 PRINT ,, D$
  50 PRINT ,, "  HERE IS THE LAW:"
  60 PRINT ,, C$
  70 GOSUB 1100
 110 GOSUB 1000
 120 PRINT AT 10,0;"A.  OHMS LAW DEALS WITH"
 130 PRINT " 1 CONDUCTORS",," 2 INSULATORS",,"
     3 SEMI-CONDUCTORS"," 4 METALS"
 170 GOSUB 1050
 180 IF A=4 THEN PRINT "YES"
 190 IF A<>4 THEN PRINT "NO"
 200 PRINT B$
 201 IF A<>4 THEN GOTO 200+A*10
 202 PRINT ,,D$
 203 PRINT ,,E$
 204 PRINT ,,F$
 205 PRINT ,,G$
 206 PRINT ,,B$
 207 GOSUB 1100
 208 IF A <>4 THEN GOTO 110
 209 GOTO 250
 210 PRINT ,,G$
 211 PRINT ,,H$
 212 PRINT ,,C$
 213 GOSUB 1100
 214 GOTO 110
 220 PRINT ,,E$
 221 PRINT ,,H$
 222 PRINT ,,C$
 223 GOSUB 1100
 224 GOTO 110
 230 PRINT ,,F$
 231 PRINT ,,H$
 232 PRINT ,,C$
 233 GOSUB 1100
 234 GOTO 110
 250 REM START NEXT FRAME
 251 PRINT  "START OF NEXT FRAME"
 999 STOP
1000 REM HEADINGS
1010 PRINT TAB 11;A$,,
1020 PRINT "TYPE THE NUMBER BY YOUR ANSWER."
1030 PRINT ,,,,"WHICH COMPLETES THE SENTENCE?"
1040 RETURN
1050 REM RESPONSE
1060 INPUT A
1070 IF A<1 OR A>4 THEN GOTO 1050
1080 CLS
1090 RETURN
1100 REM CONTINUE
1110 PRINT AT 21,0;"PRESS N/L TO GO ON."
1120 INPUT A$
1130 CLS
1140 RETURN
```

■

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HOW TO TACKLE VIC COLOUR AND SOUND

Despite the fact that Vic-20s are now appearing on the market in large volumes, software for the £200 Commodore machine is still in short supply. To give you some ideas for writing your own programs, Tim Hartnell presents subroutines which generate sound and colour.

LET US LOOK at some of the colour-graphics functions. Enter this program, run it, then examine the listing to see what it is doing:

```
10 FOR J = 8 TO 127 STEP 17
20 POKE 36879,J
30 PRINT "CLR NEXT COLOUR"
40 INPUT A$
50 NEXT J
```

This shows Poke in use to create a series of different colours. Location 36879 is one of the Vic system variables. It is used to store two pieces of information: the colour of the screen, and the colour of the border. By incrementing our For-Next loop in steps of 17, we are changing both the screen-colour and the border-colour together.

Change line 10 to

```
FOR J = 136 TO 248 STEP 16
```

Now notice that the screen changes but the border does not. Note that eight new colours have been generated — orange, light-orange, pink, light-cyan, light-purple, light-green, light-blue and light-yellow.

To discover what number you have to Poke into 36879, let S equal the colour of the screen, and let B equal the colour of the border.

Use the numbers given here:

Screen	$	Border	B
Black	0	Black	0
White	1	White	1
Red	2	Red	2
Cyan	3	Cyan	3
Purple	4	Purple	4
Green	5	Green	5
Blue	6	Blue	6
Yellow	7	Yellow	7
Orange	8		
Light-orange	9		
Pink	10		
Light-cyan	11		
Light-purple	12		
Light-green	13		
Light-blue	14		
Light-yellow	15		

and use the formula

```
16*S + B + 8
```

to combine them. Thus to obtain an orange screen with a white border, just use the statement

```
POKE 36879, 16*S + 1 + 8.
```

Try this:

```
10 INPUT "CLR FIRST COLOUR";S
20 INPUT "SECOND COLOUR";B
30 POKE 36879, 16*S + B + 8
40 GOTO 10
```

Run it and input number from the tables. Now change line 30 to

```
POKE 36879, 16* S + B
```

that is, within the plus eight, and run it again, inputting the same numbers.

Let us Poke into the Vic's colour memory-map area.

```
10 FOR J = 1 TO 506
20 PRINT "shift Q";
30 NEXT J
40 POKE 38400 + INT(506*RND(1)) + 1,
   INT(8*RND(1)) + 1
50 GOTO 40
```

Lines 10 to 30 fill the screen. Line 40 is the interesting one. It Pokes a random number between one and eight — this represents one of eight different colours — into one of the addresses between 38400 and 38906. They are the colour addresses for the screen — one address for each print position. Note that there are 506 such positions, since the screen is 22 by 23: Now try

```
10 PRINT MID$("RED CYN PUR GRN BLU
   YEL",INT(6*RND(1)) + 1, 1); "shift Q";
20 GOTO 10
```

Line 10 is rather clever — the first part selects a new colour at random. Notice how the function Mid$ is used to select a single character from the string of colour controls.

The core of this program is simple. Feed it into your computer and after pressing Run, input any six letters and/or spaces, then press Return.

```
10 INPUT A$
20 FOR J = 1 TO 75
30 PRINT A$;
40 NEXT J
```

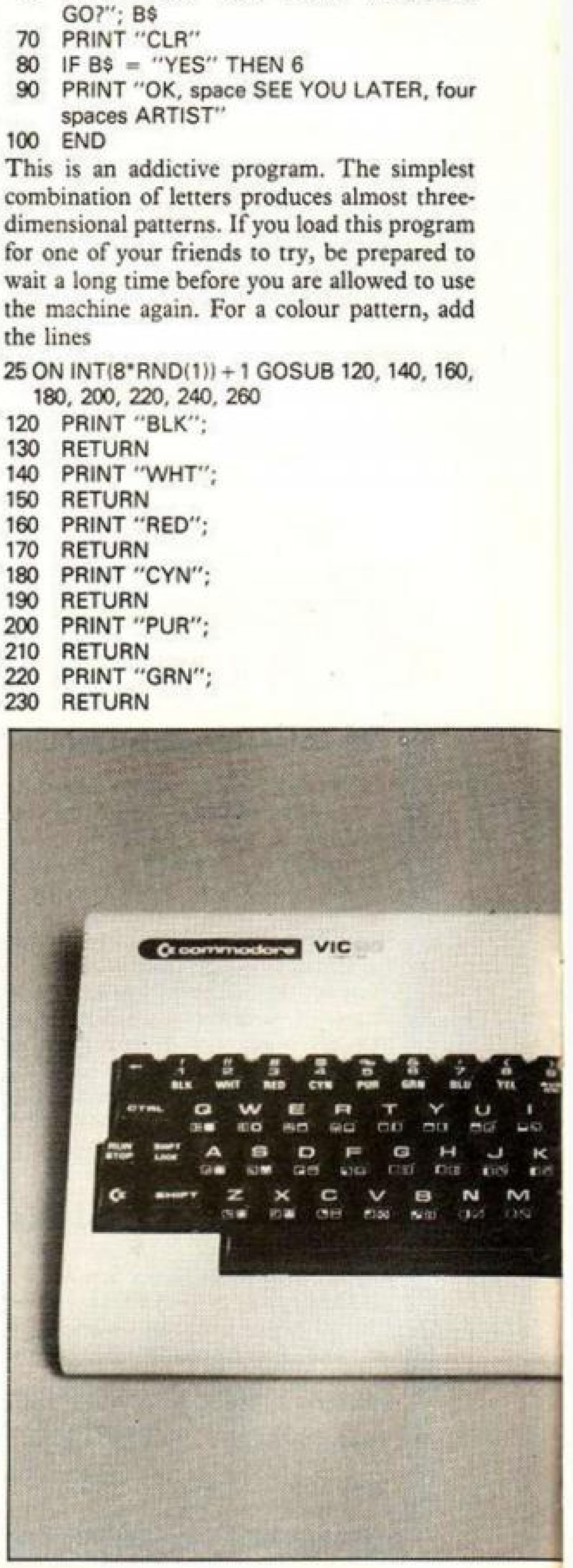
You can run this program, which is surprisingly effective, using any combination of letters, numbers and symbols. You will find that one or two spaces, instead of letters, enhance the pattern produced. Try a few more patterns, using spaces, letters like M and W, the $ sign, the numbers 6 and 9 and the graphics symbols.

Write a routine around the core program to include: a title; instructions; and the chance to form anothern pattern without having to return to command mode and press Run again. One way — and there are many — is as follows:

```
1 PRINT, "PATTERNS"
3 PRINT
6 PRINT "PRESS ANY COMBINATION OF
  6 LETTERS, one space SYMBOLS AND
  SPACES . . ."
8 PRINT
10 INPUT ". . . AND I WILL PRINT A
   PATTERN";A$
15 PRINT "CLR"
20 FOR J = 1 TO 75
30 PRINT A$;
40 NEXT J
50 PRINT
60 INPUT "DO YOU WANT ANOTHER
   GO?"; B$
70 PRINT "CLR"
80 IF B$ = "YES" THEN 6
90 PRINT "OK, space SEE YOU LATER, four
   spaces ARTIST"
100 END
```

This is an addictive program. The simplest combination of letters produces almost three-dimensional patterns. If you load this program for one of your friends to try, be prepared to wait a long time before you are allowed to use the machine again. For a colour pattern, add the lines

```
25 ON INT(8*RND(1)) + 1 GOSUB 120, 140, 160,
   180, 200, 220, 240, 260
120 PRINT "BLK";
130 RETURN
140 PRINT "WHT";
150 RETURN
160 PRINT "RED";
170 RETURN
180 PRINT "CYN";
190 RETURN
200 PRINT "PUR";
210 RETURN
220 PRINT "GRN";
230 RETURN
```



```
240 PRINT "BLU";
250 RETURN
260 PRINT "YEL";
```

Line 25 means if the random number expression is 1 then Gosub 120; if the random number is 2 then Gosub 140, and so on up to Gosub 260. Look at the subroutines themselves. You will need to use the CTRL key to obtain the colour keys. For a balanced colour program, enter and run the following.

```
10 PRINT "RED"; CHR$(INT(32*RND(1)) + 96);
20 PRINT "CYN"; CHR$(INT(32*RND(1)) + 96);
30 PRINT "PUR"; CHR$(INT(32*RND(1)) + 96);
40 PRINT "GRN"; CHR$(INT(32*RND(1)) + 96);
50 PRINT "YEL"; CHR$(INT(32*RND(1)) + 96);
60 PRINT "BLU"; CHR$(INT(32*RND(1)) + 96),
70 GOTO 10
```

Try changing the comma in line 60 to a semicolon. You can make the program a little shorter using the Def statement. Add line 1 as follows:

```
1 DEF FNR(X) = INT(32*RND(X)) + 96)
```

now whenever you see the phrase

```
INT(32*RND(1)) + 96)
```

in the program, lines 10-60, replace it with

```
FNR(1)
```

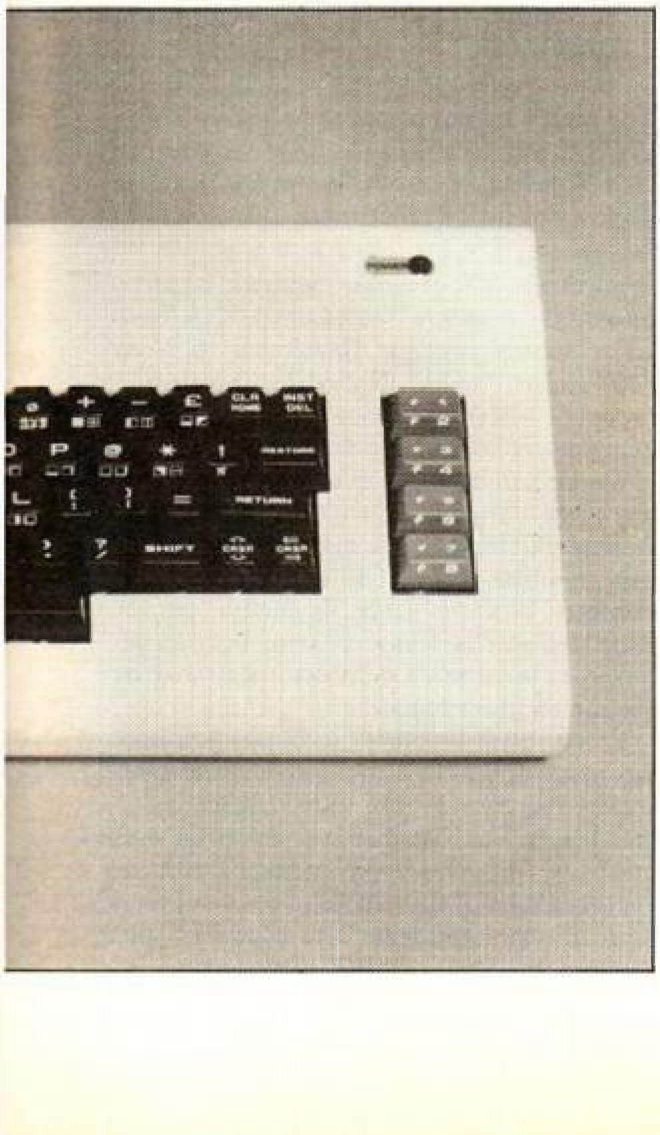
Whenever the computer encounters the word FNR it looks at line one which tells it what it means.

To explore the Vic's music-making abilities type the following lines of program:

```
10 S1=36874
20 S2=36875
30 S3=36876
40 S4=36877
50 V=36878
```

S1 stands for speaker 1, S2 stands for speaker 2, S3 stands for speaker 3, and S4 stands for speaker 4. V is for volume. The numbers after the equals sign are the Vic's music-producing numbers. You must always use these numbers when making music.

To generate sound we must use the Poke statement. Let us first see how to generate silence. Add the following lines — these form a subroutine:



```
500 FOR A=S1 TO V
510 POKE A,0
520 NEXT
530 RETURN
```

Notice that we have Poked all four speakers, and the volume, with zero. Add the following lines and then run the program.

```
100 GOSUB 500
110 POKE V,5
120 FOR A=128 TO 255
130 POKE S1,A
140 FOR B=1 TO 50: NEXT B
150 NEXT A
160 GOSUB 500
170 END
```

The number 5 we Poked into V was the volume level. The number we Poked into S1 was the tone. You should have discovered this by running it. Change line 130 to Poke S2,A and run it again. Change it to Poke S3,A and run it once more. For the biggest surprise of all, make line 130 Poke S4,A and run it again. S1, S2 and S3 are there to make music — S4 produces noise.

Type New. Now input the following program:

```
10 READ N
20 PRINT N
30 GOTO 10
9000 DATA 17,16,42,99,0,57,123
```

Line 10 instructed the computer to Read a new value into the variable N. It obtained the value 17 from the Data statement in line 9000. The next time round it Read the value 16 into N, then 42, and so on up to 123. This time when it tried to Read N it had run out of data, and so stopped with the out-of-data error message.

We can use Read and Data to help the Vic to play a tune:

```
10 S1=36874
10 S2=36875
20 S3=36876
30 S4=36877
50 V=36878
100 GOSUB 500
110 POKE V,4
120 FOR A=1 TO 16
130 READ N
140 POKE S2,N
150 FOR B=1 TO 1000:NEXT B
160 NEXT A
170 GOSUB 500
180 END
500 FOR A=S1 TO V
510 POKE A,0
520 NEXT
530 RETURN
9000 DATA 135,147,159,135
9010 DATA 135,147,159,135
9020 DATA 159,163,175,175
9030 DATA 159,163,175,175
```

This table will help you to improve the tune. It tells you what values of N you need to Poke to make the notes required.

Note	Value	Note	Value	Note	Value
C	135	C	195	C	225
C#	143	C#	199	C#	227
D	147	D	201	D	228
D#	151	D#	203	D#	229
E	159	E	207	E	231
F	163	F	209	F	232
F#	167	F#	212	F#	233
G	175	G	215	G	235
G#	179	G#	217	G#	236
A	183	A	219	A	237
A#	187	A#	221	A#	238
B	191	B	223	B	239
				C	240
				C#	241

There is no reason why the computer cannot be programmed to write its own music. Here are a few programs which do just that. Just change a few of the lines you already have then examine the listings and work out how they do it. Write a few similar programs of your own.

```
DELETE 9000-9030
DELETE 130
140 POKE S1,INT(128*RND(1)) + 128
```

Then add the following and run the program again:

```
DELETE 120
160 GOTO 140
```

You must press Stop to break from the program, and run 500 to stop the music. Now wipe the program, and try the following which writes its own music, and adds lighting effects:

```
10 S1=36874
20 S2=36875
30 V=36878
40 C=36879
50 POKE V,4
60 DIM N(8)
70 DIM B(4)
80 PRINT "CLR"
100 GOSUB 500
110 FOR A=1 TO 8
120 READ N(A)
130 NEXT
140 N=INT(8*RND(1))+1
150 B(1)=N
160 FORA=2 TO 4
170 GOSUB 400
180 B(A)=N
190 NEXT A
200 FOR A=1 TO 4
210 POKE S1,N(B(A))
220 FOR B=1 TO 2
230 GOSUB 400
240 POKE S2,N(N)
250 POKE C,16*B(A)+N
260 FOR J=1 TO 250: NEXT
270 NEXT B
280 NEXT A
290 GOTO 200
400 N=N+INT(3*RND(1))-1
410 IF N=9 THEN N=8
420 IF N=0 THEN N=1
430 RETURN
500 FOR A=S1 TO V
510 POKE A,0
520 NEXT
530 RETURN
9000 DATA 195,201,207,209,215
9010 DATA 219,223, 225
```

To break from the program, press Stop and type Goto 500. If you would like a simpler program:

```
20 S2=36875
30 V=36878
40 C=36879
50 POKE V,4
60 DIMN(8)
80 PRINT "CLR"
100 GOSUB 500
110 FOR A=1 TO 8
120 READ N(A)
130 NEXT
140 N=INT(8*RND(1))+1
240 POKE S2, N(N)
250 POKE C,N
260 FOR J=1 TO 1000: NEXT
290 GOTO 140
500 FOR A=S1 TO V
510 POKE A,0
520 NEXT
530 RETURN
9000 DATA 195,201,207,209,215
9010 DATA 219,223,225.
```

Again, you need to press Stop and type Goto 5000 to break from the program. ■

MACHINE CODE
STARTING WITH THE

If the merest mention of stacks, operands or mnemonics fills you with a profound sense of gloom, then you may count yourself among the growing band of those who suffer from machine-code phobia. The cure prescribed by specialist Les May consists of a salutory look at the very roots of the malady — binary, hexadecimal, bits, bytes and registers.

Hexadecimal					Binary					Decimal				
16^4	16^3	16^2	16^1	1	16	8	4	2	1	10^4	10^3	10^2	10^1	1
				0					0					0
				1					1					1
				2				1	0					2
				3				1	1					3
				4			1	0	0					4
				5			1	0	1					5
				6			1	1	0					6
				7			1	1	1					7
				8		1	0	0	0					8
				9		1	0	0	1					9
				A		1	0	1	0				1	0
				B		1	0	1	1				1	1
				C		1	1	0	0				1	2
				D		1	1	0	1				1	3
				E		1	1	1	0				1	4
				F		1	1	1	1				1	5
			1	0	1	0	0	0	0				1	6

Figure 1.

HIGH-LEVEL LANGUAGES are assumed to be more powerful and easier to use than low-level ones. In this high-level category we might put Pascal, Comal, Basic and Fortran. The low-level category contains the various assemblers. By powerful we usually mean that each line of program can do far more than a line of assembler. Often we also mean that it has more features, If-Then, Let, Gosub and so on.

There is, however, a penalty for this power and convenience. High-level language programs usually occupy more memory and run more slowly than low-level ones. If you have a ZX-81, you will be well aware of how quickly the 1K of memory fills. Some kinds of operations where the computer is used to control or monitor some external device may not be possible with a high-level language or, if possible, may be awkward and the response may be much too slow. One might, in these circumstances, describe a program as powerful if it could monitor the condition of a single bit every few millionths of a second and respond to any change in the same length of time. To obtain this kind of power, one has to forgo the advantages of a high-level language by going to the opposite end of the scale and learning to program in machine code.

Inside the chip

To penetrate the mystique which surrounds machine code it will be necessary to understand a little about the internal structure of computers, especially the microprocessor chip and about two less familiar numbering systems, binary and hexadecimal.

The simplest computer possible would consist of some memory, a processor chip, a program and a power supply. It would be a computer but could do little which was useful. To be of any use it must have some means of communicating with the outside world. At the simplest level this might be nothing more than a number of switches and lamps.

This is rather a tedious way of doing things and in practice a keyboard and video display would be more usual. To look at the keyboard and output data to the display, the computer will hold a program in ROM. This is usually called a monitor.

Computers have been made which operate directly in the decimal system but it is much simpler to make one which operates in the binary system and to use the power of the computer to convert numbers to the decimal system when they have to be communicated to humans.

Before we look at the binary system, let us examine our familiar decimal system a little more closely. Consider the number

1 2 3

What does it mean? If you think back to your days in junior school you might remember writing it something like this

H T U
1 2 3

In other words we have

1 Hundred
2 Tens
3 Units
or $100 + 20 + 3 = 123$

By a similar process any number can be oroken down into its parts. The columns can be extended as far as we wish to the left. How do we choose what the headings are? Notice that the first column is "units" or "ones". The second is "tens". Heading for the third column is "hundreds".

$$100 = 10 \times 10$$

The fourth column should, of course, be headed "thousands": notice again that

$$1000 = 10 \times 10 \times 10$$

So this is our rule: "Each column to the left is 10 times more than its neighbour on the right".

There are two points to learn here. First the number 10 is called the number base. Second for convenience $10 \times 10 \times 10 \times 10$ would be abbreviated to 10^4 — similarly, a million could be written as 10^6. Any number can be chosen as the number base.

Now that we have looked at the decimal system we are ready to apply the same ideas to the binary system. Rule three sets of five columns down a piece of paper. Ignore the left-hand sets of columns for the moment but put the words "decimal" over the right-hand set and "binary" over the middle set. Enter the correct power of 10 at the top of each of the decimal columns. When you have finished it should look something like this — see figure 1:

$$10^4 \quad 10^3 \quad 10^2 \quad 10^1 \quad 1$$

The binary system uses 2 as its number base. Write the correct power of 2 at the head of each of the centre set of columns but this time work it out first. For example,

$$2^3 = 2 \times 2 \times 2 = 8$$

Now let us look at binary numbers. Begin by putting the numbers 0 to 16 in the right-hand set or decimal columns. Remember 16 is one "10" and six "units". Notice that there are 17 numbers — learning about machine code will help you rediscover that zero is a number.

Working in base 10 you were allowed to put any of the 10 numbers, 0 to 9, in each column. In binary arithmetic you may put either of the two numbers 0 or 1 in any column. Any number, however large or small, can be expressed in the binary system, but for our purposes the first 17 numbers are all that we require for the moment.

To represent a number in binary you need far more digits than to represent the same number in decimal. This disadvantage is outweighed by the fact that the pattern of ones and zeros you write for any number is an exact representation of the pattern of ones and zeros held in the computer to represent that number.

ESSENTIALS

Writing 10000001 can at times be much more meaningful than 129. They are the same number in fact and when you Poke 129 you are putting that pattern into the computer memory. There are several points to learn about binary numbers which can be illustrated using this number

*   +
10000001

The term digit is commonly used to describe the individual symbols in decimal numbers. This is replaced by the term "bit" in binary. Also, the left-hand 1 marked with an asterisk is worth considerably more than the right-hand 1 marked with a plus sign. It is in fact worth 2^7 or 128. Hence 10000001 can be thought of as

1 one hundred and twenty-eight
0 sixty-four
0 thirty-two
0 sixteen
0 eight
0 four
0 two
1 one
or 128 + 1 = 129

To take account of this, the furthest left-hand bit is called the "most significant bit" or MSB and the furthest right-hand bit, the "least significant bit" or LSB. The maximum number you can represent with eight bits is 255. A group of eight bits like this has become known as a byte; you may also see the term "eight-bit words". Another term which may seem facetious but is, in fact, useful is "nybble" for a group of four bits.

While the bit pattern held in the computer may be most easily represented by a similar bit pattern on paper, a program written in this way would be very difficult to follow and very prone to error. What is required is a system which combines the economy of decimal digits with binary's ease of identifying the bit pattern in a byte. A moment's reflection will convince you that you require a high number base and that this base must itself be a power of two. In the very early days of microcomputers, base eight or octal was used. This made use of the eight numbers 0 to 7 and any digit in octal represented three bits of binary. For example

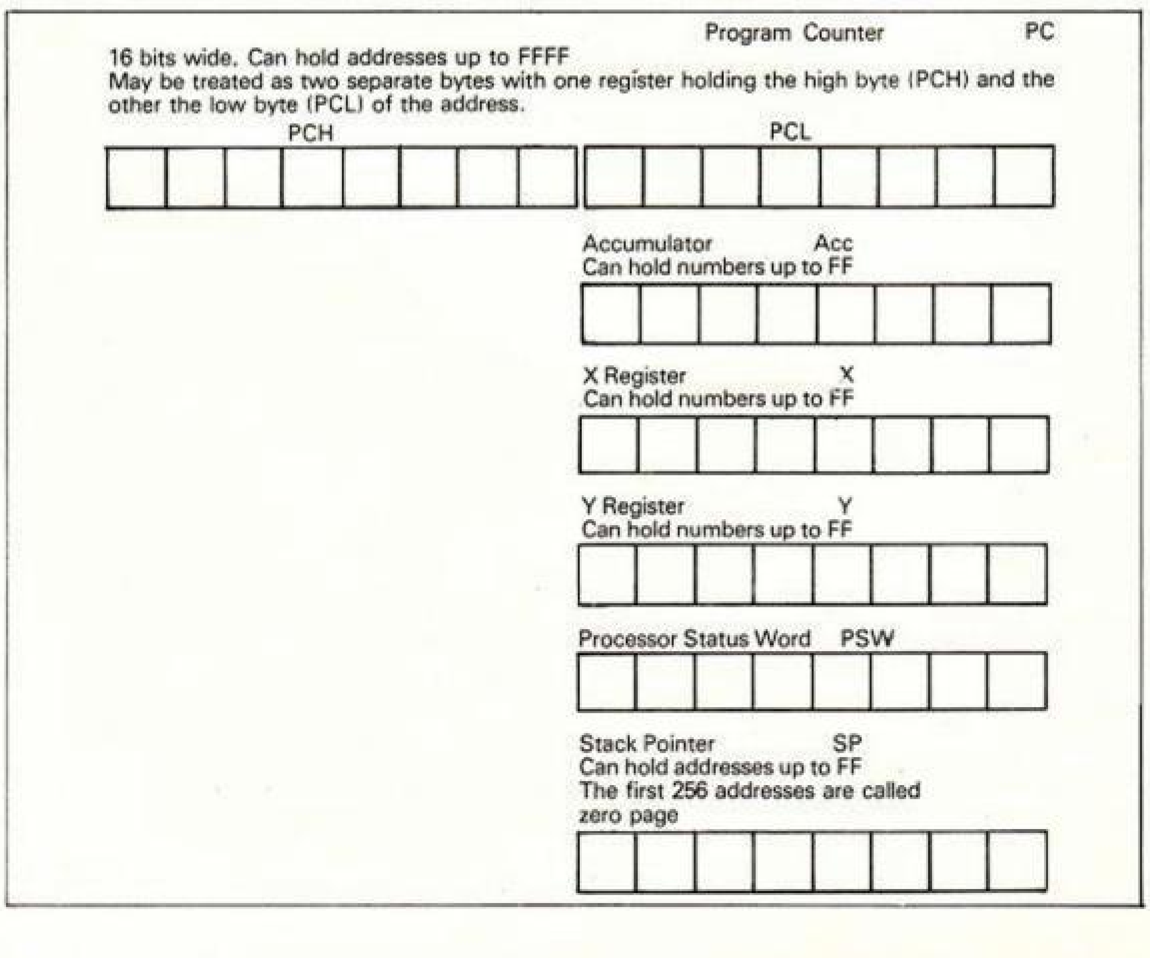
octal 75 = binary 111 101 = decimal 61

However, the most common microprocessors all deal with eight bits, while two octal digits cannot represent more than six bits. As a result all machine-code programming is done nowadays using numbers in base 16 or hexadecimal — figure 1.

The first 10 digits of hexadecimal are the familar digits 0 to 9 but the last six press into service the first six letters of the alphabet, A to F. In this case they represent not a sound but a number. So, 23 decimal equals 17 hexadecimal — one 16 and seven units. With two hexadecimal digits you can represent up to 256 decimal numbers and with four hexadecimal digits you can represent up to 65,536 decimal numbers. Sinclair Research has simplified matters by giving decimal equivalents of all the hexadecimal numbers between 00 and FF and forcing you to enter machine-code programs in decimal.

I mentioned that the term nybble is used for a group of four bits. You may have noticed that four bits can be represented by the 16 numbers 0 to F in hexadecimal. By considering a byte as two separate nybbles, one can quickly convert the bit pattern into a hexadecimal number using a table of bit patterns for each of the 16 numbers because the same hexadecimal digit represents the same bit pattern in each nybble.

Figure 2. Registers of the 6502. Other CPUs have different arrangements of registers.



Processing data

As we saw earlier the simplest useful computer system need consist of only memory, a microprocessor chip or CPU and some method of in- and outputting data. Unseen by the user are a collection of interconnections grouped together into two buses along which signals may flow between the CPU and memory. Some CPUs use only one bus to carry the two kinds of signal at different times.

One of the two buses carries the pattern of bits which corresponds to the address of a memory location. Perhaps the simplest analogy for memory locations is to think of a stack of trays numbered from zero in hexadecimal. The common CPUs require an address bus 16 connections wide.

Since there are 65,536 ways of arranging a pattern of 16 bits so any pattern of bits will identify only one location in the memory. 16 bits can be represented by four hexadecimal digits. Just because a CPU can address 65,536 memory locations does not mean it has to have that much memory available to it nor must the memory necessarily follow on from one area to another.

When the CPU looks to see what is in the memory, it is said to be reading. When it is storing something in memory, it is writing. Some areas of memory only permit reading and are called ROM. If reading and writing are permitted the memory is called RAM.

The way different areas of memory are allocated their functions can be seen from the memory map. Studying this carefully will tell you into which parts of the memory you can load machine code.

The second bus carries data. In this context the word data can mean a number, a bit pattern, a part of an address or an instruction. The common microprocessors have a data bus eight connections wide which allows 256 bit patterns to be carried and conveniently represented by any two hexadecimal digits.

(continued on next page)

(continued from previous page)

Inside the microprocessor are a number of registers, each capable of holding a pattern eight bits wide. You can examine and modify these registers directly or indirectly by using the monitor program which looks at the keyboard and is responsible for the display.

Some microprocessors permit two eight-bit-wide registers to be combined to form a single 16-bit-wide register. The number of registers provided depends on the chip you have in your computer. We shall be considering the 6502 chip used in the Micron, Apple, Pet and Acorn Atom, but the underlying principles can be applied to almost any other common processor.

Flags and stacks

There are seven registers in the 6502 — see figure 2. Two are combined to give a 16-bit-wide register, the program counter. This keeps track of the address of the instruction the processor is to execute next.

The accumulator, A, is the main working register — all the arithmetic and logical operations take place between the accumulator and memory. Two other registers are labelled X and Y and perform a much more limited range of operations than the A register.

They are commonly used for counting the number of times the program performs a loop or for indexed addressing.

When an instruction has been executed it is useful to have some indication of the results. This is provided by the processor-status word, PSW, held by the sixth register. The bits in the PSW are called flags and when a bit is at logic 1 the flag is said to be "set". When at logic 0 the flag is "reset". Each flag is affected by different conditions resulting from the last operation or data movement.

For example, if the hexadecimal number 2A were moved into the accumulator, the zero flag would be reset indicating that the result of the last operation was not zero. This may seem a rather trivial facility for the microprocessor to have, but programs can be made to branch depending on the result of an operation, and conditional branches are among the most powerful instructions available.

Sometimes the computer has to break from the smooth flow of a program and perform another job for a short time. For example, a burglar opening the back window has interrupted your Space Invader program, and the computer has jumped to a section of program which calls the police.

While waiting for the police you can continue your game because the first thing the police-calling program would do is store the registers A, X, Y and PSW in a portion of memory known as the "stack". The "interrupt" itself would store the program counter.

Putting things on the stack is called "pushing"; removing them is called "popping" and is done when the program called by the interrupt has completed its operation and a return to the original program is required.

The stack is also used when subroutines are called or for temporary storage of a register. The stack pointer points to the memory location where the last item was stored.

Whatever microprocessor chip your computer contains, it will have some or all of these features. Consider the following Basic program:

```
10  LET A = 255
20  LET A = A-1
30  IF A>0 THEN 20
40  PRINT A
50  BREAK
```

Although at first sight this program would look very different written in machine code, the individual steps would be remarkably similar. In a Basic program one does not have to say where in memory it is to be loaded, which register the variable A is to be put into or from where the computer is to start executing its instructions from — Run does this automatically.

Nor does one have to give the address of the subroutine which will cause the result to be displayed — Print in Basic. In machine code, however, you will have to do all these things yourself, but you are still helped a little.

Most monitors contain very useful subroutines which are available to the machine-code programmer. Careful study of a well-documented monitor will prove very valuable when writing your own programs.

We often forget that what we call programming consists of two separate and distinct processes. First, the programmer decides on the steps by which his objective is to be achieved. Then he codes it in a form suitable for the computer to understand. Carrying out the first of these we obtain something like this:

- Load register A with 255 decimal
- Take 1 from register A
- If the result is not 0, jump back to the last step
- Jump to the subroutine for displaying the result
- Break

Each line can be considered as an instruction which consists itself of two parts; an operation — do this — and an operand — to this. Such a program would be very clumsy and time-consuming to write. Recognising this, the micro manufacturers have given each operation a mnemonic code which is an easy-to-understand abbreviation.

Writing the same program in mnemonic code for the operations we have;

```
LDA
DEC
BNE
JSR
BRK
```

Most machine-code programs are written initially in this form using the appropriate mnemonics. The mnemonics must now be hand-assembled by replacing each one with its appropriate op-code. Fully assembled and with the operations and addresses added, it would look something like this — starting address 0400:

```
0400  A9 FF
0402  C6
0403  D0
0405  20 75 FE
0408  00
```

Each pair of hexadecimal digits, one byte, occupies one location in memory. Each memory location requires four hexadecimal digits to define it. Notice also that in writing the assembled program, each line contains one instruction, i.e., one operation plus one operand, which is why the program appears to skip over some memory locations.

Looking at the program one may wonder how the computer knows whether a pair of digits is intended to be an op-code or an operand: in fact, it does not know. Rather, it operates in a similar way to the single-key entry mode of the ZX-80/1 where if a key is pressed after a line number, it must be a command.

When a machine-code program is executed, the starting address is entered and the first byte encountered is treated as an op-code. In our example, executing the program from 0400 will cause the first byte, A9, to be read as an op-code meaning: "Load register A with the number which follows".

Executing the same program from 0401 will cause the first byte read, FF, to be treated as an op-code. Depending on the microprocessor concerned, FF may or may not be a valid op-code. In any event, the result would not be what was intended.

A serious machine-code programmer would invest in an assembler which is in effect a low-level language. Such a facility, held in ROM or loaded from tape as required, allows the mnemonic for the operation, followed by the operand, to be entered.

At the end of each line, the assembler translates the operation into the correct op-code and allocates it together with the operand to memory. Clearly, this procedure is less tedious than hand-assembling a program by looking up the op-code in the system manual.

Disassembler listing

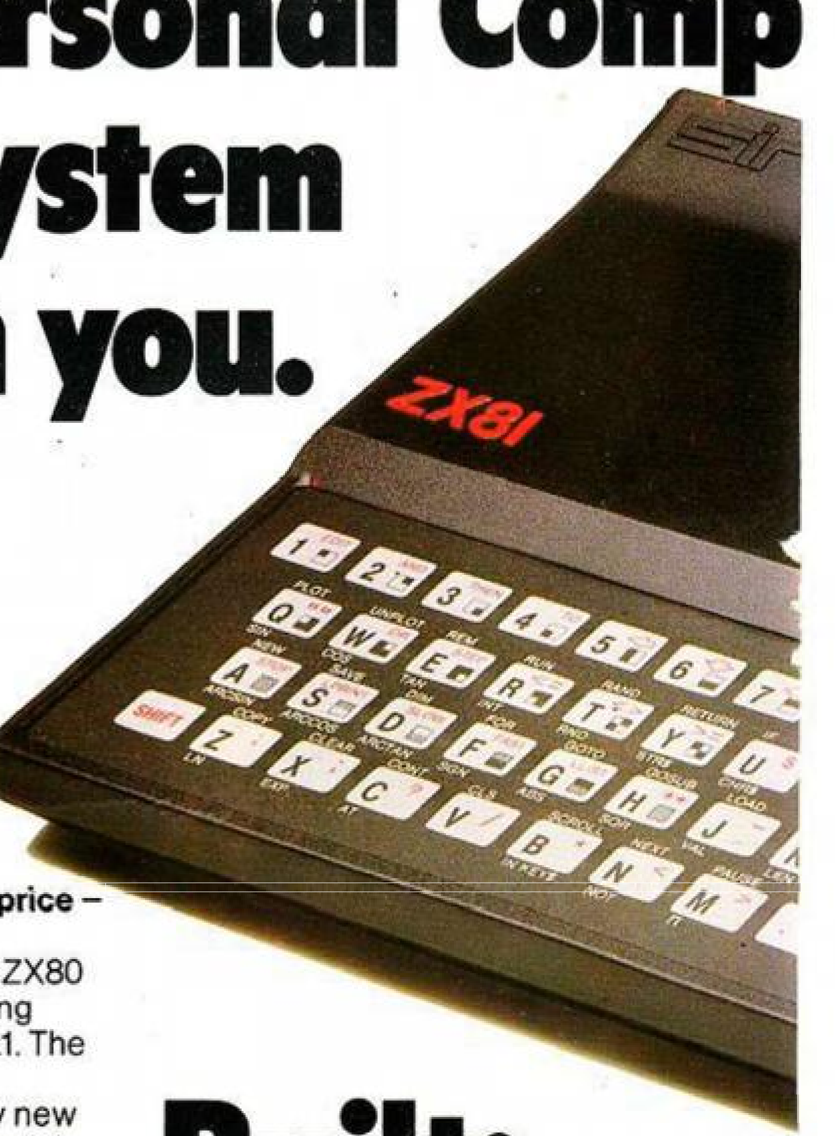
Translator-type assemblers are very efficient in the use of memory and identical in length with a hand-assembled program. Some assemblers are very sophisticated and save the programmer a good deal of work in other ways, too. For example, it may be possible to give an address a label. When a branch to this address is required, the programmer need only type the appropriate mnemonic followed by the label; the assembler will then insert the appropriate number of steps the program must jump. Even if you hand-assemble all your programs, this is a useful idea to imitate.

If, for example, you require to set a time delay at a number of points in the program, then labelling this delay timer as well as specifying the address every time the subroutine is called, is an excellent way to keep track of what is supposed to be happening in the program.

If you are familiar with Basic you will know how useful it is to be able to List a program when debugging it. An assembler causes the mnemonic to be converted to the correct op-code and stored in memory. To look at the op-code in memory and convert it back to the appropriate mnemonic requires a program which does just the opposite. Not unexpectedly, it is called a disassembler and superficially it acts in a similar way to listing a Basic program. A disassembler acts independently of an assembler and can be used even with hand-assembled programs loaded from a hexadecimal.

There are horses for courses and only a masochist would write machine-code programs for number-crunching. Yet for fast-moving games or control from the computer, you will have backed a winner. ■

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uter-



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Write fast-moving on your ZX-81

Martin Buckeley shows you how to write a series of machine-code subroutines, culminating in a fast game of Breakout.

FOR THOSE NEW to machine code, a register comprises eight cells or bits which represent values rising in powers of two from the right. Each register can thus hold a value between 0 and 255 depending on which cells are set — that is, those which contain ones — and those which are not — those which contain zeros.

The seven registers which can be addressed directly are identified by the letters a,b,c,d,e,h,l. Registers bc, de, and hl can operate in pairs to represent values from 0 to 65,535 — that is, 256 multiplied by the left register added to the right register. In the example, register b has the value 64, and register c the value 136, but the pair together represent the value 16,520.

b

0	1	0	0	0	0	0	0
128	64	32	16	8	4	2	1

c

1	0	0	0	1	0	0	0
128	64	32	16	8	4	2	1

Register a is an accumulator register used for additions and comparisons.

In machine code, the Z-80A is addressed directly using numbers in the range 0 to 255. The two numbers 203 (CB h) and 237 (ED h) act in a similar manner to shift keys. Used as a prefix, they extend the list of machine code commands to 559. A full list of these codes appears in appendix A of the ZX-81 manual, but here are a few examples to enlarge on the mnemonics used:

ld a,b	Load register a with the value of register b.
ld a,N	Load register a with the next number in the list.
cp N	Compare with the following number — returns a zero if true.
add a,b	Add the value of register b to register a.
inc b	Increment register b.
dec b	Decrement register b.
ld hl,NN	Load register pair hl with the values of the next two numbers.
ld de,(NN)	Load register pair de with the value held at memory location (N + 256*N)
jp NN	Jump to memory location (N + 256*N)
jpz,NN	Jump if zero to location (N + 256*N)
jpnz,NN	Jump if not zero to NN
jr DIS	Relative jump to the memory location indicated by the next number. N less than 127 jumps forward. N greater than 128 jumps 255-N backwards.
call NN	Equivalent to Basic Gosub
ret	Equivalent to Basic Return
ret z	Return if zero

Before launching into the Breakout program we ought to have a rough outline of what we require, and I propose to tackle the job under the following four headings: move ball, move bat, draw board and the scoring mechanism.

All four jobs require a routine to plot a character at a given location — the equivalent of the Print At instruction in Basic — and this will be our first subroutine. We will use registers b and c independently to hold the column and line positions, and register a to hold the character to be plotted.

(BASIC : PRINT AT c,b;CHR$ a)

The de and hl registers are used to compile the address of the memory location equivalent to the required screen position. 16396 holds the address of the start of the display file. What we require our subroutine to do is count forward 32 characters for each line, skip any end-of-line markers — 118 — and add the column position.

Now we can start programming. We need to reserve memory to hold the program and this is done as suggested by Sinclair, behind the first Rem. Switch on and key:

100 REM

followed by 340 zeros — about 10.5 lines. When your finger recovers, enter lines 900 to 980 of our code loader.

For reasons I shall explain later, we commence our subroutine at memory location 16520, so Run the program and enter 16520 to the first prompt. Now enter the code numbers in column two of the list, and the ZX-81 should print out the first two columns for you. When you reach

16552 201 C9 ret

enter 999, and the program should stop.

To test this routine, we must assign values to registers a,b, and c, and this is achieved in the next few lines. Run the program again. This time start at memory location 16514, and enter:

16514	62	ld a,N	
16515	61		Code for an 'X'
16516	6	ld b,N	
16517	0		Column number
16518	14	ld c,N	
16519	0		Line number
	000	STOP program	

If you now type

LET A = USR 16514

you should see an "X" appear in the top left of your screen. To vary its position, Poke a new line number — 0 to 15 only since 16 will crash — into 16519 and a new column number — 0 to 31 — into 16517. You can Poke any code you like into 16515.

Now that we have a plotting routine, it is time to think about how to move the ball. This is achieved by deleting the existing ball, changing the line and column position and then replotting the ball.

There are four pieces of information we require to do this, and we shall store them in the locations indicated:

Ball position	Current line number	16507
	Current column number	16508
	Horizontal direction	16514
	Vertical direction	16515

To avoid negative values, the ball direction

Driver and loader program.

```
300 CLS
310 LET A = USR 16742             REM PRINT BOARD
320 PRINT AT 17,0;"SCORE (6 spaces) BALL"
322 PRINT AT 19,0;"KEYS 1/0 MOVE BAT"
324 PRINT AT 20,0;"NEWLINE DELIVERS BALL"
330 POKE 16507, INT (RND*12)+2   REM RANDOM LINE NUMBER 2-13
340 POKE 16515,2
350 POKE 16514, INT (RND*2)*2    REM RANDOM DIRN. 0 or 2
360 POKE 16517,CODE INKEY$
370 IF CODE INKEY$=118 THEN GOTO 420
400 LET A=USR 16593
410 GOTO 360
420 IF PEEK 16518 = 252 THEN GOTO 300
430 POKE 16508,2
440 LET A = USR 16593
450 POKE 16517,CODE INKEY$
460 IF PEEK 16508=0 THEN GOTO 510
470 IF PEEK 16518 > 100 THEN GOTO 440
480 IF PEEK 16518 > 50 THEN GOTO 440
490 IF PEEK 16518 > 20 THEN GOTO 440
500 GOTO 440
510 PRINT AT 17,6;PEEK 16518
520 PRINT AT 17,16;PEEK 16519
530 GOTO 330
900 PRINT "START LOCATION"
910 INPUT A
920FOR N=A TO 16850
930 INPUT B
940 IF B>255 THEN STOP
950 PRINT AT 18,0;N;"(space)";B
960 SCROLL
970 POKE N,B
980 NEXT N
990 STOP
```

graphics

is indicated by either a 0 which decreases line/column value, or 2 which increases line/column number. To find the new ball position we will use the formula:

New Position = Old Position + Indicator − 1

Load your program and then Run. For the start location enter 16643 and all the lines up to 16680.

The next thing to consider is how to change the direction indicators. This is done in the lines 16553 to 16565, where for any given memory location in hl a 0 will be changed to a 2 and a 2 to a 0. Run the program again and with line 16553 as the start location, key in lines 16553 to 16565.

The next two sections of the program enter either the horizontal or vertical indicator locations into hl before calling the switch routine. The start location is 16566 and the routine ends at 16580.

We must now consider the conditions for switching the vertical indicator:

- The ball is in line 1
- The ball is in line 14

and those for switching the column indicator:

- The ball is in column 28
- The ball hits the bat
- It hits a front brick in the wall
- It hits a back brick in the wall

In the next section we cover these conditions and also keep a tally of deleted bricks counting 1 for a brick from the front wall and 5 for one in the rear wall. Further, we will keep a tally of balls used. So, the start location is 16681 and the codes run to 16741.

To test the program so far, we must now enter a few lines of the Basic program which will act as the controlling program. Use my line numbering as there are further lines to be inserted later.

```
300 POKE 16518, 0
310 POKE 16519, 0
330 POKE 16507, INT(RND *12)+2
340 POKE 16514, INT(RND *2)*2
350 POKE 16515, 2
430 POKE 16508, 2
440 LET A = USR 16612
460 IF PEEK 16508 = 0 THEN GOTO 510
500 GOTO 440
510 INPUT A$
520 GOTO 330
```

If everything is working, Run should produce a ball bouncing around the screen. If you have problems delete lines 930 to 960 inclusive, add

```
950 PRINT N;"space";PEEK N
```

then Goto 900 and check your listing.

Our project is now nearing completion, but as yet we still need a moving bat, the board, and a way of presenting the score.

Three CHR$ 133s make a reasonably-sized bat, and using Basic to Poke keystrokes into 16517 we can transfer bat moves into the

```
16520    38 26   ld h,N
16521     0 00
16522   105 69   ld l,c
16523   203 CB
16524    37 25   sla l
16525   203 CB
16526    37 25   sla l
16527   203 CB
16528    37 25   sla l
16529   203 CB
16530    37 25   sla l
16531   203 CB
16532    37 25   sla l
16533   203 CB
16534    20 14   rlh
16535    89 59   ld e,c
16536    22 16   ld d,N
16537     0 00
16538    25 19   add hl,de
16539    88 58   ld e,b
16540    25 19   add hl,de
16541   237 ED
16542    91 5B   ld de,(NN)
16543    12 0C
16544    64 40
16545    25 19   add hl,de
16546    17 11   ld de,NN
16547     1 01
16548     0 00
16549    25 19   add hl,de
16550    86 56   ld d,(hl)
16551   119 77   ld (hl),a
16552   201 C9   ret
16553   126 7E   ld a,(hl)
16554   254 FE   cp N
16555     0 00
16556    32 20   jrnz DIS
16557     4 04
16558    60 3C   inc a
16559    60 3C   inc a
16560    24 18   jr DIS
16561     2 02
16562    61 3D   dec a
16563    61 3D   dec a
16564   119 77   ld (hl),a
16565   201 C9   ret
16566    33 21   ld hl,NN
16567   130 82
16568    64 40
16569   205 CD   call NN
16570   169 A9
16571    64 40
16572    24 18   jr DIS
16573   116 74
16574    33 21   ld hl,NN
16575   131 83
16576    64 40
16577   205 CD   call NN
16578   169 A9
16579    64 40
16580   201 C9   ret
16581   121 79   ld a,c
16582   254 FE   cp N
16583     0 00
16584   200 C8   ret z
16585    13 0D   dec c
16586   201 C9   ret
16587   121 79   ld a,c
16588   254 FE   cp N
16589    13 0D
16590   200 C8   ret z
16591    12 0C   inc c
16592   201 C9   ret
16593     6 06   ld b,N
16594     1 01
16595    62 3E   ld a,N
16596     0 00
16597    33 21   ld hl,NN
16598   132 84
16599    64 40
16600    78 4E   ld c,(hl)
16601   205 CD   call NN
16602   136 88
16603    64 40
16604    13 0D   dec c
16605   205 CD   call NN
16606   136 88
16607    64 40
16608    13 0D   dec c
16609   205 CD   call NN
16610   136 88
16611    64 40
16612    33 21   ld hl,NN
16613   133 85
```

(continued on next page)

machine-code program. We shall have to stop the bat exceeding the game area, but it will always be in column 1, so we need only store its line number — in 16516. Load the program again and Goto 900. Now enter lines 16581 to 16642.

Now enter 999 and then key this line:

```
450 POKE 16517, CODE INKEY$
```

This section of the program can now be tested by entering the Basic line

```
440 LET A = USR 16593
```

and running it. If all is well, the bat should run up and down the left-hand side of the screen.

We now arrive at the board-drawing routine. It is feasible to write this in Basic, and you might like to try it to compare execution speed. Goto 900 then and the start location is 16742. The board-drawing routine ends at 16809.

That is the end of the machine code, all that now remains is to complete the Basic driver program. The whole program is shown in listing 1. Lines 470 to 490 vary the speed of the ball and may be omitted for a faster game, or alternatively substitute:

```
470 FOR Q = 1 TO 3
490 NEXT Q
```

for a slower game. Using Pause introduces a flicker into an otherwise rock-steady performance. The addition of lines 322 and 324 make the program a little more user-friendly.

```
322 PRINT AT 19,0;"KEYS 1/0 MOVE THE BAT"
324 PRINT AT 20,0;"NEWLINE DELIVERS THE BALL"
```

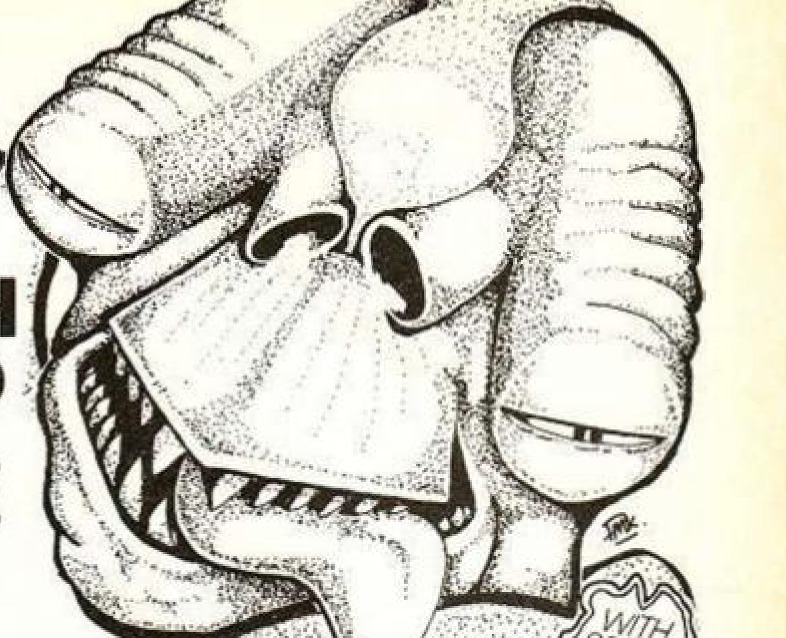
You now have the basic ingredients for writing your own fast-moving games programs. A full listing of this program is available from me at 33 Stoneham Lane, Swaythling, Southampton. Please send £1 plus a stamped, addressed envelope; and an extra £1.50 if you want a cassette as well.

(continued from previous page)

```
16614   64 40
16615  126 7E  ld a,(hl)
16616  254 FE  cp N
16617   29 1D
16618  204 CC  call z,NN
16619  197 C5
16620   64 40
16621  254 FE  cp N
16622   28 1C
16623  204 CC  call z,NN
16624  203 CB
16625   64 40
16626   62 3E  ld a,N
16627  133 85
16628  205 CD  call NN
16629  136 88
16630   64 40
16631   12 0C  inc c
16632  205 CD  call NN
16633  136 88
16634   64 40
16635   12 0C  inc c
16636  205 CD  call NN
16637  136 88
16638   64 40
16639  121 79  ld a,c
16640   50 32  ld(NN),a
16641  132 84
16642   64 40
16643   33 21  ld hl,NN
16644  123 7B
16645   64 40
16646   78 4E  ld c,(hl)
16647   35 23  inc hl
16648   70 46  ld b,(hl)
16649  120 78  ld a,b
16650  254 FE  cp N
16651    0 00
16652  200 C8  ret z
16653   62 3E  ld a,N
16654    0 00
16655  205 CD  call NN
16656  136 88
16657   64 40
16658   17 11  ld de,NN
16659  123 7B
16660   64 40
16661   33 21  ld hl,NN
16662  130 82
16663   64 40
16664  126 7E  ld a,(hl)
16665  129 81  add a,c
16666   61 3D  dec a
16667   79 4F  ld c,a
16668   18 12  ld (de),a
16669   35 23  inc hl
16670   19 13  inc de
16671  126 7E  ld a,(hl)
16672  128 80  add a,b
16673   61 3D  dec a
16674   71 47  ld b,a
16675   18 12  ld (de),a
16676   62 3E  ld a,N
16677   52 34
16678  205 CD  call NN
16679  136 88
16680   64 40
16681  121 79  ld a,c
16682  254 FE  cp N
16683    1 01
16684   40 28  jrz DIS
16685  136 88
16686  254 FE  cp N
16687   14 0E
16688   40 28  jrz DIS
16689  132 84
16690  120 78  ld a,b
16691  254 FE  cp N
16692   28 1C
16693   40 28  jrz DIS
16694  135 87
16695  254 FE  cp N
16696    0 00
16697   40 28  jrz DIS
16698   28 1C
16699  122 7A  ld a,d
16700  254 FE  cp N
16701  133 85
16702  202 CA  jp z,NN
16703  190 BE
16704   64 40
16705  254 FE  cp N
16706    8 08
16707   40 28  jrz DIS
16708    7 07
16709  254 FE  cp N
16710  189 BD
16711  192 C0  ret nz
16712   30 1E  ld e,N
16713    5 05
16714   24 18  jr DIS
16715    2 02
16716   30 1E  ld e,N
16717    1 01
16718   33 21  ld hl,NN
16719  134 86
16720   64 40
16721  126 7E  ld a,(hl)
16722  131 83  add a,e
16723  119 77  ld (hl),a
16724  195 C3  jp NN
16725  190 BE
16726   64 40
16727   33 21  ld hl,NN
16728  135 87
16729   64 40
16730   52 34  inc(hl)
16731   62 3E  ld a,N
16732    2 02
16733   50 32  ld(NN),a
16734  131 83
16735   64 40
16736   62 3E  ld a,N
16737    0 00
16738  205 CD  call NN
16739  136 88
16740   64 40
16741  201 C9  ret
16742   62 3E  ld a,N
16743  128 80
16744    6 06  ld b,N
16745   29 1D
16746   14 0E  ld c,N
16747   15 0F
16748  205 CD  call NN
16749  136 88
16750   64 40
16751   13 0D  dec c
16752   32 20  jrnz DIS
16753  250 FA
16754   14 0E  ld c,N
16755    0 00
16756  205 CD  call NN
16757  136 88
16758   64 40
16759   14 0E  ld c,N
16760   15 0F
16761  205 CD  call NN
16762  136 88
16763   64 40
16764    5 05  dec b
16765   32 20  jrnz DIS
16766  243 F3
16767    6 06  ld b,N
16768   21 15
16769   14 0E  ld c,N
16770   14 0E
16771   62 3E  ld a,N
16772  189 BD
16773  205 CD  call NN
16774  136 88
16775   64 40
16776   13 0D  dec c
16777   32 20  jrnz DIS
16778  250 FA
16779    5 05  dec b
16780  120 78  ld a,b
16781  254 FE  cp N
16782   18 12
16783   32 20  jrnz DIS
16784  240 F0
16785   14 0E  ld c,N
16786   14 0E
16787   62 3E  ld a,N
16788    8 08
16789  205 CD  call NN
16790  136 88
16791   64 40
16792   13 0D  dec c
16793   32 20  jrnz DIS
16794  250 FA
16795    5 05  dec b
16796  120 78  ld a,b
16797  254 FE  cp N
16798   15 0F
16799   32 20  jrnz DIS
16800  240 F0
16801   33 21  ld hl,NN
16802  134 86
16803   64 40
16804   54 36  ld(hl),N
16805    0 00
16806   35 23  inc hl
16807   54 36  ld(hl),N
16808    0 00
16809  201 C9  ret
16810    0 00  nop
16811    0 00  nop
16812    0 00  nop
16813    0 00  nop
16814    0 00  nop
16815    0 00  nop
16816    0 00  nop
16817    0 00  nop
16818    0 00  nop
16819    0 00  nop
```

■

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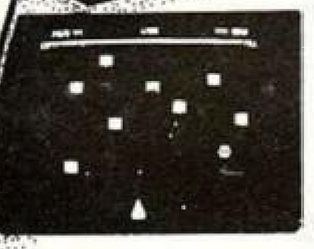
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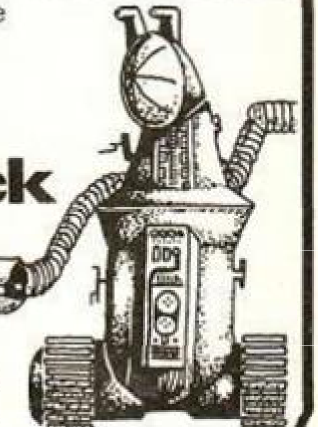
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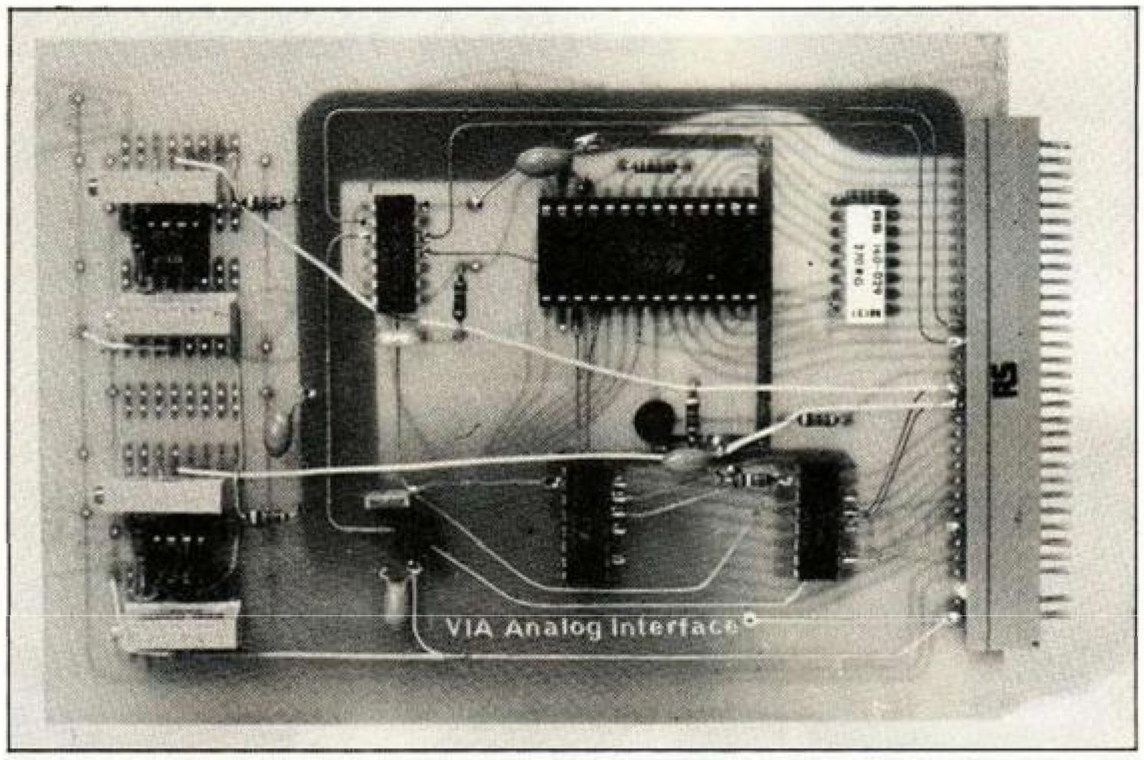
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☐ Please send me..
I enclose a cheque/postal order for £ ......
(plus 50p post & packing)

Signature ....
Name ....
Address ....
Postcode ....
My ACCESS No is ....

PROJECT

DIGITISING ANALOGUE

Continuing his series on the development of process-control software, John Dawson tackles the crucial problem of converting information from external equipment into machine-readable form.



The Original Microsystems VIA interface, with input from the multiplexer taken to the comparator.

IN THE FIRST article in the series I described a very simple digital-to-analogue converter (D-A) which produced a voltage from a digital number. This article is about the reverse process, analogue-to-digital conversion (A-D), and the uses to which an A-D converter can be put for gathering data from the real world for the computer to act on.

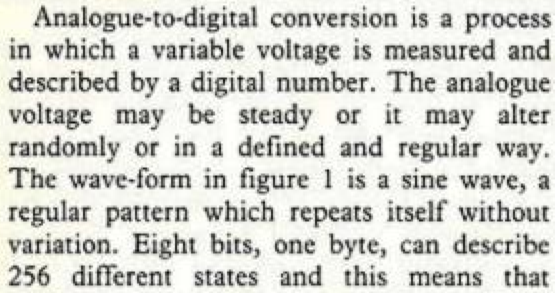
The listings give a program for setting the time on the clock program I listed last month. I have found an error in the clock software — nothing catastrophic, just that the week counter does not increment without another instruction STA WK inserted before line 150.

Analogue-to-digital conversion is a process in which a variable voltage is measured and described by a digital number. The analogue voltage may be steady or it may alter randomly or in a defined and regular way. The wave-form in figure 1 is a sine wave, a regular pattern which repeats itself without variation. Eight bits, one byte, can describe 256 different states and this means that analogue voltage somwhere between 0 and 2.55V can be measured to an accuracy of 10mV that is, one-hundredth of a volt.

Recently, 10-bit and 12-bit A-D converters have become less expensive and more common. They resolve or measure a signal voltage to one part in 1,000 or one part in 4,000 respectively. The increased accuracy is almost irrelevant for domestic measurements and most of the work done in school laboratories.

Most A-D converters use a technique known as successive approximation. There is, however, a second method which is faster, but more expensive, called flash conversion. Successive approximation uses a converter to produce a voltage from numbers generated by the A-D board.

Figure 1. Voltage changes more rapidly when it crosses the zero point (a) than near a peak (b).



The reference voltage is compared with the unknown, incoming analogue voltage and the A-D chip hunts for the closest match between the reference and the unknown. When all eight bits of the converter are set to the best match to the unknown voltage, the conversion is finished and the computer reads the digital number as the measurement of the analogue voltage.

Successive approximation uses one comparator circuit; in contrast, flash conversion is performed using one comparator circuit for each possible state of the output. So, for an eight-bit converter, 256 comparators would be necessary — hence the increased cost; while for a 10-bit converter, 1,024 comparators would be required. Flash converters can be used, however, for converting TV signals from one standard to another which involves working at frequencies up to 10-15MHz.

The versatile interface adaptor chip (VIA) analogue interface produced by Original Microsystems Ltd at 39 High Street, North Crawley, Newport Pagnell, Buckinghamshire, is intended for the Tangerine Microtan computer. However, the board will interface to any 6522 VIA chip and is just as suitable for the Aim 65, Acorn Atom, or the BBC microcomputer.

The board has eight unipolar analogue inputs. That means that the inputs will measure either positive or negative in relation to zero but not both, in this case 0 to +5V. There are also two D-A converters on the board and a prototyping area in which operational amplifiers or other circuits can be hand-wired.

The board is made of glass fibre and is double-sided but not through-plated. The board fits comfortably into the Tangerine rack and all the input and output connections are brought to a standard 0.1in. pitch, 32-way connector. The advantage of this system is that you can move the board from one computer to another by unplugging it and changing the connector for one which has been wired for the VIA outlet of the new machine.

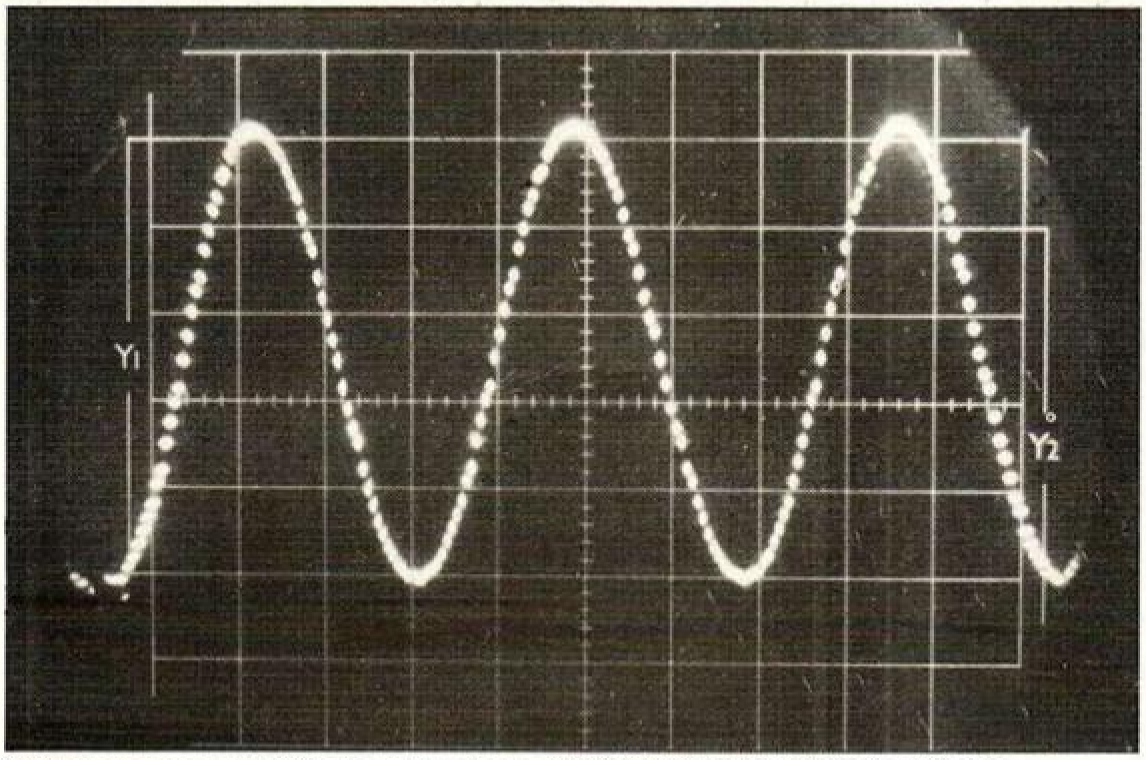
In a normal form the board costs £95; the version supplied for this review had two CA-3140 optional amplifiers added to the outputs from the Ferranti D-A converters. The ADC-0809 integrated circuit takes between 100 and 150µs. to read an analogue voltage and return the digital equivalent. The input is taken straight from the multiplexer, the circuit that selects one of the eight inputs, to the comparator.

There is no provision in this chip for sampling and then holding the input while the conversion is carried out. The consequence is that for an accurate conversion, the input must be stable to within a small fraction of the input voltage for 100µus. at least.

The calculations to find the exact limits at which the chip will work accurately are set out in the *Data Conversion Handbook* by Donald S Bruck but it may be reduced to this:

■ For an eight-bit A-D with a full-scale input

SIGNALS



Oscilloscope trace of a 50Hz sine wave after conversion to digital and back to analogue.

voltage of 5V, the input must not change more than 5/512V(=9,9998V) in 100μs. or 98V/second.

- The maximum rate of change of a sine wave occurs when the voltage passes through zero — figure 1. In the case of a 5V full-scale sine wave,

Frequency = rate of change = (2π × 5)

Hence,

Frequency = 98/31.4 = approximately 3.1Hz.

For many applications the ADC-0809 chip will be completely satisfactory, for example:

- Test voltage measurement.
- Digitiser tablet where position is found from pressure on a surface.
- Temperature control in a greenhouse or for central-heating purposes.
- Wind direction, rainfall, humidity, and other meteorological data.
- Measurement of the position of machinery, perhaps a drilling jig.

The Original Microsystems board is unlikely to be successful in applications such as:

- Process control where there is a possibility of positive feedback.
- Speech analysis.
- Physiological data capture such as heart rhythms, electrical changes in the muscles and nervous reflexes.

Despite the calculations, I am uncertain whether or not the Original Microsystem board will be useful for the scanning camera I intend to build for a forthcoming article. A 50Hz sine wave was analysed using the Original Microsystems converters and turned back into an analogue signal using the D-A converter on the board. It gave reasonably accurate representation of the original and I shall have to do more work to see just what jobs can be done using this board.

The second A-D board I want to describe in this article is made by Sagus for I/O Systems Limited. It costs £135 and is intended specifically for the Nascom microcomputer. The 8in.-by-8in. board plugs directly into the Nasbus and is made of glass fibre with printed-circuit wiring on both sides and plated-through connections. A silk-screen print is used on one side to identify each component and the board will be completed with a solder-resist mask. The edge connectors are gold-plated.

There is a PI/O chip on the board connected through buffers to the Nasbus address and data lines. None of the connections to the Nasbus imposes more than one LS TTL load to the Nasbus lines.

There is a generous prototyping area in one corner of the board to which all the Nasbus voltage rails are bought, with provision for decoupling capacitors close to any integrated circuits mounted in the prototype area. Eight miniature jack sockets are provided on the outer edge of the A-D board for the eight analogue inputs and the input lines can be broken close to each jack socket so that the analogue signal can be routed through operational amplifiers mounted in the prototype area to condition the incoming signal before it is passed to the analogue multiplexer.

The multiplexer chip selects one of the eight analogue channels and puts the same analogue voltage on the output from the chip. The chip used by Sagus is made by Harris and has integral protection against excessive input voltages. It can handle transient overloads of several hundred volts.

(continued on page 55)

```
0058 :
0059 :
0060 :
0061 :
0062 :
0063 :   DECIMAL TO BCD INPUT
0064 :
0065 DECIN  PHP
0066        PHA
0067        TXA
0068        PHA
0069        TYA
0070        PHA
0071        JSR DIGIT
0072        CMP £$0D
0073        BEQ DN2
0074        ASL @
0075        ASL @
0076        ASL @
0077        ASL @
0078        STA SD
0079        JSR DIGIT
0080        CMP £$0D
0081        BEQ DN2
0082        ORA SD
0083        STA SD
0084 DN2    PLA
0085        TAY
0086        PLA
0087        TAX
0088        PLA
0089        PLP
```

```
0606
0606
0606
0606
0606
0606
0606
0606
0606 08
0607 48
0608 8A
0609 48
060A 98
060B 48
060C 20 2B 06
060F C9 0D
0611 F0 11
0613 0A
0614 0A
0615 0A
0616 0A
0617 85 80
0619 20 2B 06
061C C9 0D
061E F0 04
0620 05 80
0622 85 80
0624 68
0625 A8
0626 68
0627 AA
0628 68
0629 28
```

```
0090        RTS
0091 DIGIT  JSR $FDFA
0092        LDA ICHAR
0093        CMP £$0D
0094        BEQ DN1
0095        CMP £$30
0096        BCC DIGIT
0097        CMP £$3A
0098        BCS DIGIT
0099        JSR OPCHR
0100        LDA ICHAR
0101        AND £$0F
0102 DN1    RTS
0103 :
0104 :
0105 :
0106 :
0107 :
0108 :
0109 :
0110 :
0111 :
0112 :
0113 :
0114 :
0115 :
0116 :
0117 :
0118 :
0119 :
0120 :
```

```
062A 60
062B 20 FA FD
062E A5 01
0630 C9 0D
0632 F0 0F
0634 C9 30
0636 90 F3
0638 C9 3A
063A B0 EF
063C 20 75 FE
063F A5 01
0641 29 0F
0643 60
0644
0644
0644
0644
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0644
0644
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0644
0644
0644
0644
```

(listing continued on page 55)

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(listing continued from page 53)

```
0121 :                              0644
0122 :                              0644
0123 :                              0644
0124 :                              0644
0125 :   SET CLOCK TIME             0644
0126 :                              0644
0127 TIMES   BYT 'S,'e,'t           0644 53 65 74
0128         BYT ' ,'T,'i           0647 20 54 69
0129         BYT 'm,'e,$00          064A 6D 65 00
0130         BYT $00                064D 00
0131         BYT 'W,'e,'e           064E 57 65 65
0132         BYT 'k,$00,'D          0651 6B 00 44
0133         BYT 'a,'y,$00          0654 61 79 00
0134         BYT 'H,'o,'u           0657 48 6F 75
0135         BYT 'r,'s,$00          065A 72 73 00
0136         BYT 'M,'i,'n           065D 4D 69 6E
0137         BYT 'u,'t,'e           0660 75 74 65
0138         BYT 's,$00,'S          0663 73 00 53
0139         BYT 'e,'c,'o           0666 65 63 6F
0140         BYT 'n,'d,'s           0669 6E 64 73
0141         BYT $01                066C 01
0142 :                              066D
0143 :                              066D
0144 :   DISPLAY TIME FRAME         066D
0145 :                              066D
0146 DTIM    PHP                    066D 08
0147         PHA                    066E 48
0148         TXA                    066F 8A
0149         PHA                    0670 48
0150         TYA                    0671 98
0151         PHA                    0672 48
0152         LDX NULL               0673 AE 03 06
0153         LDA NULL               0676 AD 03 06
0154         STA ZP1                0679 85 7F
0155 SM2     TAY                    067B A8
0156 SM1     LDA TIMES,X            067C BD 44 06
0157         CMP NULL               067F CD 03 06
0158         BEQ STMX               0682 F0 12
0159         CMP £$01               0684 C9 01
0160         BEQ STMZ               0686 F0 07
0161         STA SCTOP,Y            0688 99 00 02
0162         INY                    068B C8
0163         INX                    068C E8
0164         BNE SM1                068D D0 ED
0165 STMZ    PLA                    068F 68
0166         TAY                    0690 A8
0167         PLA                    0691 68
0168         TAX                    0692 AA
0169         PLA                    0693 68
0170         PLP                    0694 28
0171         RTS                    0695 60
0172 STMX    LDA £$20               0696 A9 20
0173         CLC                    0698 18
0174         ADC ZP1                0699 65 7F
0175         STA ZP1                069B 85 7F
0176         INX                    069D E8
0177         JMP SM2                069E 4C 7B 06
0178 :                              06A1
0179 :                              06A1
0180 :                              06A1
0181 :                              06A1
0182 :                              06A1
0183 :                              06A1
0184 :                              06A1
0185 :                              06A1
0186 :                              06A1
0187 :                              06A1
0188 :                              06A1
0189 :                              06A1
0190 :                              06A1
0191 :                              06A1
0192 :                              06A1
0193 :                              06EE
0250 :                              06EE
0251 :                              06EE
0252 :                              06EE
0253 :                              06EE
0254 :                              06EE
0255 :                              06EE
0256 :   TIME SET                   06EE
0257 :                              06EE
0258 TIME    JSR CLS                06EE 20 D6 06
0259         JSR DTIM               06F1 20 6D 06
0260         LDX £00                06F4 A2 00
0261         LDA £$40               06F6 A9 40
0262         STA ICURS              06F8 85 0A
0263         LDA £$02               06FA A9 02
0264         STA ICURSH             06FC 85 0B
0265 TE1     LDY £$0A               06FE A0 0A
0266         STY VDUIND             0700 84 03
0267         LDA £$5F               0702 A9 5F
0268         STA (ICURS),Y          0704 91 0A
0269 TE2     JSR DECIN              0706 20 06 06
0270         LDA ICHAR              0709 A5 01
0271         CMP CR                 070B CD 04 06
0272         BEQ DT2                070E F0 0E
0273         JSR $FDFA              0710 20 FA FD
0274         LDA ICHAR              0713 A5 01
0275         CMP CR                 0715 CD 04 06
0276         BNE TE3                0718 D0 1A
0277         LDA SD                 071A A5 80
0278         STA WK,X               071C 95 F8
0279 DT2     CLC                    071E 18
0280         LDA £$20               071F A9 20
0281         INY                    0721 C8
0282         INY                    0722 C8
0283         STA (ICURS),Y          0723 91 0A
0284         ADC ICURS              0725 65 0A
0285         STA ICURS              0727 85 0A
0286         INX                    0729 E8
0287         CPX £$05               072A E0 05
0288         BNE TE1                072C D0 D0
0289         JSR CLS                072E 20 D6 06
0290         JMP ST1                0731 4C A4 06
0291 TE3     LDY £$0A               0734 A0 0A
0292         LDA £$20               0736 A9 20
0293 TE4     STA (ICURS),Y          0738 91 0A
0294         INY                    073A C8
0295         CPY £$1F               073B C0 1F
0296         BNE TE4                073D D0 F9
0297         JMP TE1                073F 4C FE 06
```

(continued from page 53)

After leaving the multiplexer, the analogue signal is then taken to a sample-and-hold circuit, and this is the crucial distinction between the board made by Original Microsystems and the one manufactured by Sagus.

The sample-and-hold circuit looks at the incoming analogue signal for about 15µs. and then holds that value while the analogue-to-digital conversion is performed. The difference between the two boards essentially is then that the amplitude of the incoming signal should not change substantially for either the whole period of the A-D conversion, 100 to 150µs. in the case of the Original Microsystems board, or for the period necessary for the sample to be taken and frozen, 15µs. in the case of the Sagus board.

In fact, the board also has an extremely fast A-D converter and the whole conversion process, including the sample and hold, takes 30µs. The designer says that the board will accurately resolve speech and other analogue signals up to a frequency of about 15kHz. The rate at which you manage to make the board work in your system will depend on how clever you are at moving each value from the Original Microsystems board and into memory.

The Sagus board dedicated to the Nascom, is more sophisticated than the Original Microsystems version and is selling well to industrial users. The Original Microsystems board seems a little overpriced in comparison but should prove a compact and useful analogue interface for applications which fall within its limits — it is a worthwhile piece of equipment to have as part of the real-time system I am building.

The majority of the software set out in the listing is concerned with the dialogue between the Tangerine Microtan computer and the computer user. For example, the subroutine "Display Time Frame" displays the information in the Times table in the top half of the Microtan VDU screen.

Line 152 — LDX NULL — is an instructin to load X with zero and the machine code at location 673 to 675 will need altering by anyone who is not using a two-pass assembler and who cannot equate the label null to a zero byte. The label SCTOP in line 161 refers to the top left-hand memory location of the Microtan VDU memory and this should be altered to suit other systems.

The time-set program first clears the screen using the subroutine CLS and then displays the frame of information with the call to the subroutine in line 259. The labels ICURS, ICURSH, VDUIND and ICHAR refer to zero-page locations used by the Microtan Tanbug monitor and it may be difficult to make a straightforward translation between this program and another system. Most of the rest of the instructions in this module are concerned with error trapping.

Non-numeric characters are rejected by lines 95-98 in DECIN, two figures are required for each input, e.g., 06 for day, and any third figure other than a carriage return blanks the line and starts the input routine again.

Pressing the return key before or during an entry skips to the next line and leaves the previous variable, e.g., hours, unaltered. It is possible to set the seconds count only by pressing the return key until a cursor or underline character appears opposite the seconds line.

The time-set module is difficult to crash and is a good example of a simple and comparatively foolproof input to the computer. When the time has been set, the program jumps to ST1 — line 290 and this instruction should be changed to suit your own program until I present the definitive start to Cogent and the source-program entry routines next month. ■

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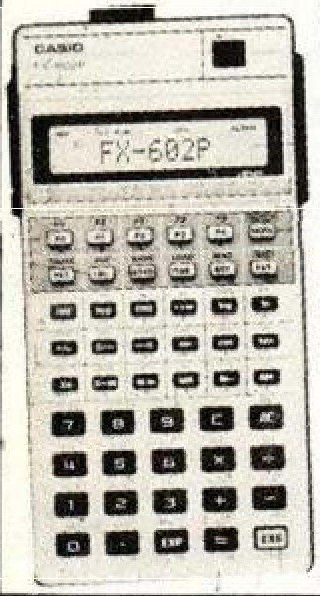
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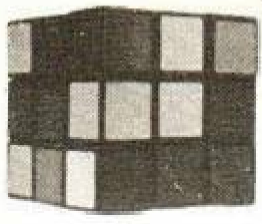
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As PROMISED SEVERAL moons ago, I am still aching to tell you about some extraordinary programming manoeuvres on the HP-41C. Before jumping in head first, you need a feeling for the memory layout of these machines.

The basic addressable unit of memory is the byte — a series of eight binary digits which, for convenience, may be thought of as two four-digit nybbles. In data memory numbers are stored as binary-coded decimal in groups of seven bytes, or registers.

Any base-10 digit — value 0 to 9 — may be expressed in terms of a four-bit binary nybble. Thus 14 nybbles can define a 10-digit number, its two-digit exponent and the sign of each. You might say, though, that we are wasting a bit of capacity here, as we never need a nybble of value greater than 9_{10} — that is, 1001_2 — in data memory. We do, in fact, have the capacity to store hexadecimal code or base 2^4 if so desired.

This property is fully utilised in program memory where each stored byte has a specific function or part of a function assigned to it. Program lines must then be thought of as single bytes, or combinations of bytes, as opposed to pieces of a register.

We will eventually see how some bytes are related to certain functions and how to program non-standard bytes — those combinations of digits not used for standard functions listed by catalogue 3.

This method, called synthetic programming, may be used to generate new characters via the display, increase the available memory and much else.

It should be immediately apparent that the stored code interpreted from data memory is translated differently to code in program memory, or, say, the alpha-numeric register. There are, then, three levels of code in the calculator.

- **User Code:** That displayed or entered on keyboard, etc.
- **Memory Code:** Series of bits of digital information, combined as bytes and registers.
- **Machine Code:** Language of the processing unit.

Translation from memory code to user code depends on what type of memory the processor has assigned to that code. To appreciate the importance of this point, perform the following:

- Insert a single-density memory module into your calculator.
- Execute a Master Clear — that is, turn off the calculator, press the button and, keeping the button still depressed, turn the calculator back on. "Memory lost" will appear on the display, so only do this if you have saved all of your valuable programs.
- Set size 063.
- Switch to program mode. Key in the lines: 01 12345
  02 STO IND 17
  03 RDN
- Switch the calculator off and remove the memory module.
- Wait one minute, replace module and turn on.
- Press RTN.
- Enter 1,594354305 EE53.
- Press SST and switch alpha on.

Where did the first character, not mentioned in the Hewlett-Packard handbook, appear from? What about that piece of *Your Computer* propaganda — YCTOPS — meaning "*Your Computer* is Tops"? Well, all the rigmarole of removing the memory module and then replacing it after its contents were lost permit us to succeed in two things.

The number entered after turning the calculator on again was interpreted as a programmable alphanumeric string. Thus YCTOPS and 1.594354305 EE53 are stored in memory as identical binary code. The stored program, if you are to look at it, is now a one-liner called STO M.

This is, in fact, a non-standard combination of bytes IND 17 and RDN interpreted as one line in that order. You will not have seen the M "status register" as such in normal programming. Figure 1 is a diagram to show how the memory of the 41-C appears in schematic form if one module is attached.

Register 0, R00, is at the interface of data and program memory — which are, you will note, labelled in opposite directions. Its absolute address in memory is held in a register so that the processor knows exactly where the division lies.

The absolute address may be defined by four nybbles — one for the byte number and the other three for the register number. The current size is simply the number of data registers between the top of the memory and R00.

With nothing at all keyed into program memory, already three bytes are accounted for. The last three bytes of the first program register contain the permanent . End . which is a permanent barrier to the address pointer. It stores the absolute position of the program byte currently being processed and forbids any entry into the lower parts of the memory system.

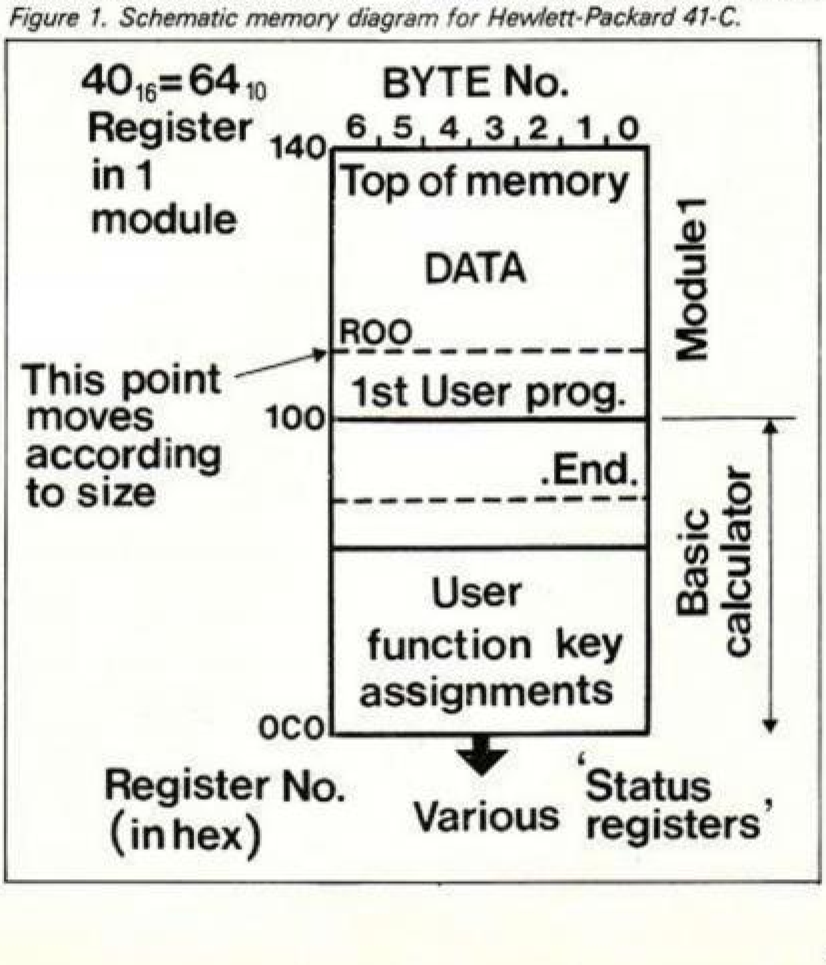
As we add more program lines, so the . End . descends automatically to the last three bytes of the lowest filled program register. The lowest part of memory shown contains the information on which keys are assigned to which functions in user mode.

The division into registers is not really vital for program memory purposes because, as I have already said, the program line in interpreted as a byte or series of bytes. I suppose it is really multi-byte lines which give the HP-41C its very advanced capabilities.

Remember how I said that every byte stored in a program had a specific function. A single-byte machine would then only have a maximum of 2^8-1 = 255 different programmable lines. That is acceptable if your calculator can only hold 30 lines. What of an HP or TI with more than 2,000?

If your machine has 200 data memories you would need 400 bytes alone to STO (re) and REC (all) them directly. The obvious solution

Figure 1. Schematic memory diagram for Hewlett-Packard 41-C.



JARGON

Hexadecimal

Hexadecimal — or hex to calculator buffs — arithmetic is base 16 as opposed to the base 10 of decimal arithmetic. In other words, the maximum value for a hexadecimal digit is 15_{10}. So that we can express all hexadecimal digits by single characters the standard notation used is $A_{16}-F_{16} = 10_{10}-15_{10}$. So $IFF_{16} = 511_{10}$. Hexadecimal is popular because it is the briefest way of expressing both nybbles and bytes of binary information. For example, the nybble 1011_2 is exactly equal to B_{16}. Hence the hexadecimal addressing system shown in Figure 1.

is to allow a combination of bytes — the HP-41C can accept up to a 16-byte series — allowing a semi-infinite number of possibilities.

For instance, the commands GTO 00 → 14 are all two-byte functions. The first byte determines the label number 00 → 14 to which the pointer is to jump. The second byte holds the information containing the direction of the jump and exactly the total number of whole registers and remaining bytes which need to be jumped.

When first written, the second byte is full of zeros — 0000 0000 — and it is only after the program has searched for the requisite label the first time that the information is written for future use. Hence, the first jump takes considerably longer than the rest.

If the first digit of this second byte is reserved for direction information, then the maximum number of steps we can record by this method are 1111_2 registers + 111_2 bytes — that is, 16_{10} registers.

For labels greater than 014 the processor forces us to use a three-byte GTO command. The extra byte lets us store as large a jump as we might wish. So if you want to save bytes and time, keep labels less than 14 and the relevant Goto within 16 registers. If, further away, the program performs a big search every loop and if your LBL and GTO must be separated by more than 16 registers or 128 bytes, it will be quicker to use a Label greater than 014.

So our poor, overworked translator has to be told not only with what kind of memory it is dealing but also, in program memory, the order of the individual bytes. In other words, the second byte of the GTO command would be interpreted entirely differently if it was on its own as a program line.

Hence the translator, when reading lines, must determine whether it is a single byte — e.g., STO 01 — or multi-byte line. This is why the BST or back-step operation often consumes a good deal of time. The pointer has to jump to the top of the

(continued on next page)

(continued from previous page)

current program file and work its way through to the previous line as it has no way of knowing whether the previous byte is part of a single or multi-byte line.

The exciting part of all this — editing our own variations of multi-byte lines and seeing what happens when we try to print, display or make a noise from them — will have to wait until next month. I shall also let you into the secret of how you can obtain all the information you ever wanted to know about synthetic programming but were afraid to ask. Until then consider:

- What separates an End statement or program Label from other pieces of program?
- Why an . End . might occupy three bytes.
- What would happen if you placed the permanent . End . in one of the memory modules and then removed the module.

Let's do it just for fun: Insert a single-density memory module and perform a Master Clear. Execute size 000 which places . End . in the module. Key in:
ASN "X< >", SHIFT, +, ASN "Σ +", Σ +

Switch off the machine and remove the memory module; wait two minutes and then replace the module. Switch on again and enter program mode. We now see 00 REG 126. Press SST once and wait a few seconds. Where are we?

Finally, two readers' programs. The first from Chris Histed of Chiselhurst, Kent.

Having just bought a Casio FX-3600P — essentially the same as a FX-3500P — I decided to write a quick game for it and chose to implement Hi-Lo, he writes. My version of this well-known game fits into the 38 steps of the calculator with a few steps remaining in memory, and uses the M memory and K memories 1 to 3.

To enter the program, enter mode 0 or programming mode, and select program 1 — P1. Now, enter the steps as shown in the listing exactly. Then still in mode 0 enter the steps for program 2. The first step is to press the dot key.

Once you have finished entering the program, you will still be in mode 0, so press mode dot, to enter run mode. Now, press P1 to run program one, and if you have pressed all the right keys, the display will go blank for about a quarter of a second and then will return, having set all the registers that program two will need, including the random number. Press P2 to run program two.

The display will produce a zero and an enter number prompt. Now you must enter your guess at the random number, between 001 and 999. Press the run key to enter your guess, and a random number will be displayed. If this is positive, your guess was too high, and if negative, your guess was too low. If you guess the number correctly, a zero will be displayed.

```
Program 1:
  -0.0001        Put this value
  inv            into M register.
  Min
  inv            Create random number.
  Ran#
  Kin 1          ...and put it into K 1.
  C              Clear display.
  Kin 3          put zero into K 3.

Program 2:
  .              Enter your number
  Ent            as a fraction
  Kin 2          Save this value in K 2.
  C              Clear Display
  (
  Kout 2         Produce a random
  -              number which is
  Kout 1         negative if K2 is less than K1
  )              positive if K2>K1 , and zero
  ×              if you guess correctly.
  inv
  Ran#
  =              Display this number.
  inv
  Hlt
  inv
  X>0            Is your number too big, if so then
  invx           return to start.
  x<Mr           is your number too low, if so return.
  999            Display 999 to tell you that you have
  inv            guessed right.
  hlt
  Kout 3         Display the number of moves i took you.
  inv
  hlt            The end folks!!!
```

Hi-Lo program for Casio FX-3600P.

After this number has appeared, press enter again to continue the program. If your guess was too low or high, another number input will be prompted, but if you had the right answer, a 999 will be displayed. Press enter again and the number of moves you took to guess it will be displayed.

Finally, a program suitable for the Sinclair Enterprise by Neil Talbot of Oxford. In my numerical version of the well-known video game Space Invaders the calculator display shows the number of invaders in each column, and how many lives you have left he writes. For example:

```
3210342.2
Number of      Lives left
invaders
per column
```

There are two invaders in the units column, four in the tens column, three in the hundreds column and so on. To shoot an invader in the units column, enter 1. For the tens column enter 10, for the hundreds column enter 100, and so on up to 1,000,000 for the millions or leftmost column.

```
00   HALT
01   ST0
02    1
03   RCL
04    0
05    ×
06    π
07    √
08    =
09   ST0
10    6
11    +
12   RCL
13    4
14    -
15   RCL
16    4
17    -
18   RCL
19    6
20   x<->y
21    -
22   ST0
23    0
24   ./EE
25    0
26    8
27    =
28   GIN
29    6
30    0
31    -
32   ./EE
33    1
34    5
35    =
36   GIN
37    7
38    7
39    -
40    .
41    0
42    6
43    =
44   GIN
45    6
46    8
47   RCL
48    1
49   +/-
50   M+
51    3
52    1
53    5
54    0
55   M+
56    5
57   GOTO
58    7
59    7
60    .
61    1
62   +/-
63   M+
64    3
65   GOTO
66    7
67    7
68    1
69    1
70    1
71    1
72    1
73    1
74    1
75   M+
76    3
77   RCL
78    3
79
```

Pre-executions:
Put 0 in store 5.
Put 1 × 10^9 (1/.EE/.RR/9) in store 4
Put 3333333.3 in store 3
Put any number between 0.3 and 1 in store 0.
Then:
GOTO/0/1/0/Run/Initial positions

Execution
Shoot — enter 1,10,100, etc.
Invaders displayed

There are four possible results: you hit an invader which is eliminated; you miss; you are shot by the invaders — you lose one life; the invaders advance and a new line is added.

The game ends when you run out of lives — the decimal place will disappear — or when the invaders land — a number five appears in one of the columns of invaders.

To find your score reclaim store 5. A score of more than 10,000 is excellent. If you destroy all the invaders, you are given a bonus life and a new batch to destroy. Press the following keys before continuing:
+ /3/3/3/3/3/3/3/.EE/1/= /STO/3/

RESPONSE FRAME

Do you have a problem? Your manual is incomprehensible or you just cannot get the hang of that programming trick you tried — whatever it is, Tim Hartnell will do his best to answer your queries. Please include only one question per letter and mark them "Response Frame".

SINCLAIR GAMES

As a 14-year-old, the prospect of playing games on my ZX-81, especially Space Invaders, interests me greatly. I have seen many advertisements of this game for my 1K of RAM, but do not know which one to buy. I would, of course, wish to buy the most realistic one, preferably without a flicker. I would prefer to buy the program on cassette. Could you please advise me on which one I should buy?

Ian Harper,
Hemel Hempstead, Hertfordshire.

It is difficult to pick out a single Space Invader program and say that is the best. Partly because we have not seen all of them in action, and partly because opinions about the best are just that — opinions. However, perhaps a useful rule to follow when buying an important program like this is not to buy the cheapest. Read advertisements in detail, and if you are near one of the suppliers, ring to see if you can have a demonstration. All ZX-81 Space Invader games are flicker-free. You will, of course, obtain a better game if you upgrade your memory, as the larger memory Space Invader programs have more flexibility.

UK 101 GRAPHICS

Please could you give me some information on how to use UK 101 graphics? All I manage is to call characters into the middle of the screen using Tab statements. This is very time-consuming and I am sure there must be an easier way. The brief Compukit manual hints at CHR character slots, but I do not know how to use them.

Andrew Ethell,
Coalville, Leicestershire.

Poking direct into the display file seems the simplest way. The manual will give you the start address of the display file.

WHY NO GO?

As a complete novice in the micro world, but eagerly awaiting my Vic-20, I am curious about several things. First, are floppy tapes useful? They appear to be half-way between cassette and disc but I do not know whether I should consider such a device for my Vic-20. Secondly, is anyone writing programs for Go instead of Chess?

J D Collins,
South Woodford.

Floppy tapes are a good and successful product, but are only made for certain computers, including the TRS-80. You require a special cassette recorder for the Vic. Draughts is relatively easy to program, since it is nearly all tactics, and so can be reduced to a series of algorithms relatively easily. Chess is a combination of strategy and tactics, and a program which compensates for the lack of strategy by painstakingly following "tactic trees" can be written, although nowhere as easily as the draughts programs. Go is a very subtle game and nearly all strategy, and that is why Go will be the last program for which a computer will be able to provide a grandmaster level of play.

ZX-80 TO ZX-81

I would like to know if it is possible to change ZX-80 programs to work on a ZX-81. If so, could you please explain how.

Martin Banks,
Bolton, Lancashire.

Many programs written for the ZX-80 will run almost as listed on an ZX-81, but will generally consume far more memory. That is, a 1K ZX-80 program will often not fit a 1K ZX-81. You will have to change the way random numbers are generated:

Old ROM	New ROM/ZX-81
LET J = RND(6)	LET J = INT(RND*6) + 1

Omit the moving display from a ZX-80 program completely. Instead of using the line

```
POKE Y*33 + X + 1 + PEEK(16396)
     + PEEK(16397)*256
```

to place a character of your choice at a position of your choice — although this routine works on both the ZX-80 and the ZX-81 — replace it with

```
PRINT AT Y,X;"BYTE"
```

on the ZX-81. Since all the graphics symbols, including inverse graphics, inverse numbers and letters, and even an inverse space, are available directly from the ZX-81 keyboard, you need not use the CHR$(n) they require on the ZX-80. To convert ZX-80 listings to ZX-81, use the following table, in which the old-ROM position is followed by the new ROM:

Shift Q, graphic 5; shift W, graphic 6; shift E, graphic 1; shift R, graphic 2; shift T, graphic D; shift A, graphic A; shift 5, graphic T; shift D, graphic 4; shift F, graphic 3; shift G, graphic S.

The first address after the word Rem on the old ROM is 16427. The equivalent address, useful for Poking into Rem statements, is 16514. The TS$ function on the old ROM can be replaced with (2 TO). That is,

```
LET A$ = TL$(A$)
```

on the ZX-80 is the same as

```
LET A$ = A$(2 TO)
```

on the ZX-81.

ZX OTHELLO

I was intrigued by the idea of the Othello program in the October 1981 edition and attempted to put it into my ZX-81 with 16K RAM. Unfortunately, I cannot make it work. The program I have put in tallies exactly with the listing printed in the magazine, except for the obvious printing error at line 810. Can you please let me know what modification is needed to run it on the ZX-81?

D Salle,
Solihull, West Midlands.

Unfortunately, the program you refer to relies heavily on the way the logic operates on the ZX-80, and this is totally different from the ZX-81. Therefore, the two cannot be exchanged. It would be easier to write an Othello program from scratch rather than try to convert the ZX-80 listing.

YOUR DECISION

I own a ZX-80 and I am interested in a new machine. I am looking at the Acorn Atom, Vic-20 and Microtan 65. Also, I could expand my ZX-80 with an 8K ROM and 16K RAM. What is your advice?

Michael Walton,
Giggleswick, Settle.

Only you can decide what you should buy next, but our advice is to write to the main suppliers of the machines you are considering buying, asking for detailed information leaflets. Then, when you have gathered enough information, answer the following questions:

- How much is the computer; can I afford it?
- Does it work in a Basic I know?
- Can I program it in Assembler?
- How much memory is there with the standard version? Is it enough for me?
- What will be the main application for the computer. Will this computer do the job satisfactorily?
- Is the machine widely used, and is there a strong users' group? — they help tremendously in making the most of your computer.
- What impression was I given by the speed and helpfulness or otherwise when I made my initial enquiries of the manufacturer? Is the manufacturer likely to be helpful with future problems and/service?

ROM AND RAM

I have just read cover to cover your journal. I am a little confused: I would dearly like to invest in a microcomputer in the price range of £50 to £150. I would like to use it for the following: business data files and word processing; map co-ordinance — non-graphic; navigation; education; and lastly, to help with the jackpot on the pools. While I can understand RAM/ROM are capacities which need to be taken into consideration, I am a little confused as to what they mean in real terms. For example, I presume I could put the A to Z of London into RAM, and could then call up any street to find my page number and co-ordinate. Could this be done on say a Sinclair ZX-80 or ZX-81, using one cassette? If not, I would like your advice on what could handle such information if any. I would prefer to pay extra for a micro which I would not outgrow in six months or so.

N Smith,
Witham, Essex.

Ram is the amount of memory you have on a computer to fill with information as you choose. ROM is the locked-in memory supplied with the machine which gives it the ability to make decisions, process numbers and the like. In general terms, the bigger the ROM and RAM, the more powerful the computer. You would need a machine which handled floppy discs for the A-to-Z map use you mention, and the ZX-81 cannot yet handle discs, although Macronics is, I believe, developing such a system. You would need, I suggest, to spend in the £300-£500 range to buy a computer which would do what you desire. If the map reference use is vital, floppy discs will be required.

VALUE OF VIC

I own a Sinclair ZX-81, with a 16K RAM pack and a good deal of software. Now I am thinking of selling it and buying a Vic. If I do, I hope I will not have to wait three months for it, as I did with my ZX-81. I am not sure, however, how much I could expect for my machine, and so wonder whether the advantages of a Vic would be worth the extra money. Can you offer any advice?

D Hollis,
Compton, Wolverhampton.

We have seen ZX-81s with 16K packs selling for around £80 to £100 which seems the going second-hand price. Despite this relatively low trade-in price, the greatly added flexibility of the Vic compared with the ZX-81 definitely makes the extra cost worthwhile.

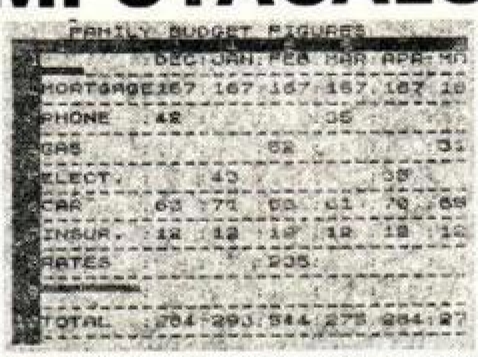
EXTRA MEMORY

I am thinking of buying either an unexpanded Atom or Microtan 65 and I was wondering which would be better for expansion, if after a while I thought I needed more memory.

Simon Jeff,
Warwick.

The ease of adding memory is, we suggest, not the most important criterion by which to choose a computer. Note that the Atom has on-board Basic while the Microtan has only hexadecimal — although it can be expanded into a Micron. Buying from the manufacturer, you can fit 12K RAM on the Atom, although at least one independent firm is selling a 128K pack which fits within the case. ■

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Effortless index

L Basford,
Crewe, Cheshire.

ZX-81

A SUCCESSION OF words or phrases as long as the RAM can accommodate is entered in any order, the program is run and, hey presto — the entries are printed in a strictly alphabetical sequence.

With 16K of RAM it is feasible to index several issues of *Your Computer* or to assemble a personal telephone directory or catalogue in detail a collection of gramophone records.

As printed here the program has been stripped down to its bare essentials to fit the unexpanded ZX-81. In this form, it will accept a maximum of 19 words of 10 characters: this is a convenient number since the result can be displayed down the screen without having to invoke Cont.

Of course, it is not restricted to words of 10 characters: the string length can be adjusted simply by changing the appropriate figure in line 30; but without extra memory one has to opt for either a greater number of shorter words or a smaller number of longer words.

The program is very straightforward and loads easily. It consists of a two-dimensional string array whose contents are inspected in lines 65-75: if any two adjacent entries are out of alphabetical order they are transposed by the subroutine of lines 85-95. A subsequent inspection — lines 105-115 — checks that each entry is by now occupying its proper place in the sequence.

Because it needs to initialise an array, the computer will ask at the outset how many words it is to receive. As soon as it has been given the answer by inputting X, the string-input cursor, L, appears and the entries can then be typed in with each one followed as usual by Newline.

After the final Newline there is a blank-screen interlude — hardly noticeable unless X is large — before the alphabetical list automatically appears on the screen.

```
10  PRINT "NUMBER OF WORDS",
15  INPUT X
20  PRINT X
25  PRINT
30  DIM A$ (X, 10)
35  FOR N = 1 TO X
40  INPUT A$ (N)
45  PRINT A$ (N)
50  NEXT N
55  FAST
60  CLS
65  FOR N = 2 TO X
70  IF A$ (N - 1) > A$ (N) THEN GOSUB 85
75  NEXT N
80  GOTO 105
85  LET Z$ = A$ (N - 1)
90  LET A$ (N - 1) = A$ (N)
95  LET A$ (N) = Z$
100 RETURN
105 FOR N = 2 TO X
110 IF A$ (N - 1)> A$ (N) THEN GOTO 65
115 NEXT N
120 SLOW
125 FOR N = 1 TO X
130 PRINT A$ (N)
135 NEXT N
```

Keyboard changes

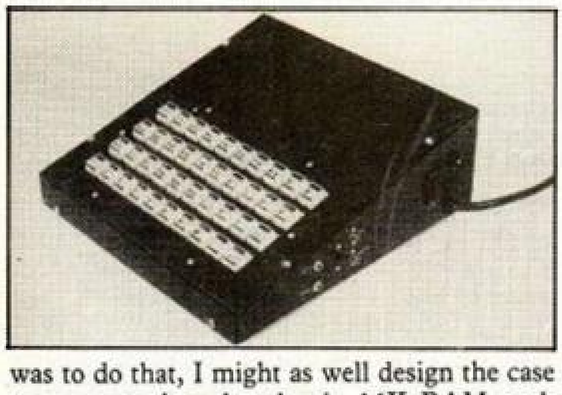
D Butler,
Chelmsford, Essex.

ZX-80

AS A NEWCOMER to computing, I was very impressed with the ZX-80, but less impressed with the way its keyboard had been engineered. I decided to see if it would be possible to fit proper key switches in place of the touch keypads.

Although there are 40 keys, there were only 13 conductors leading from the keypad circuit to the main computer itself. I found some suitable switches from Maplin Electronic Supplies to do the job. The switch is bought as one item; the key top and Perspex cover are bought as another.

It was obvious from the start that the original case would not accommodate the new keys so I had to think about a new case. If I



was to do that, I might as well design the case to accommodate the plug-in 16K RAM pack and the power supply.

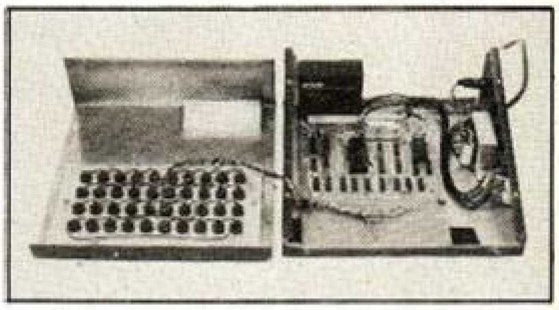
To decide the case dimensions I first took the printed-circuit board and plugged on the 16K RAM pack and measured from the front edge of the board to the back of the RAM. That gave me the depth. The width was decided by laying 10 of the key tops side by side and adding 1.125in. either side. I chose the height at the back of the case by measuring the height of the RAM pack and adding 0.5in. The front was decided to be 1in.

The key-switch panel was made from a sheet of aluminium 8.75in. by 5in. Four rows of 10 0.5in. holes were drilled in the panel, each row is 1in. apart: the holes in each row are 0.75in. apart. When the holes were drilled, five lengths of 0.25in.-by-0.25in. aluminium strip were glued between the rows. These strips act as spacers and allow the key panel to be suspended 0.25in. below the top cover — see figure 1.

The top cover was made to fit the main case with a 7.5in.-by-3.75in. hole cut in the top, 1in. from the front to allow the key tops to pass through. Four of the key switches complete with key tops and covers were fitted to the corner holes in the key panel, and the panel was then clamped into position under the top cover making sure the switches were free to move.

Clearance holes for 4BA fixings were then drilled through the top cover, through the key panel and through the aluminium strips to allow for fixing with 4BA nuts and bolts. I then cut holes in the side of the case to allow for tape recorder, and video sockets, also a rocker-type mains switch and fuse holder. When all the metal work was completed, the case, cover and key panel were given three coats of matt-black spray paint.

Next, I stripped the power supply and made a bracket of aluminium to fit over the transformer and mounted this on the right-hand side to the rear of the case. I fitted switches and sockets to the case, using miniature TV sockets for the video and new jack sockets for the recorder connections. I made a small modification to the video output to allow either a



monitor or a TV to be used with a small slide switch to switch between the two.

At this stage I also decided to make the modification on the PCB suggested by Sinclair to reverse the video display from black letters on a white background to white letters on a black background — much less eye-strain. It might have been better to have used a changeover switch to allow one to switch between the two. While using the ZX-80 in its original case, the voltage regulator became very hot after half an hour or more, so I removed it from the printed-circuit board, extended the leads on the regulator and mounted it on the side of the case, which now acts as a very efficient heat-sink.

The hole in the board left by the regulator was used as one of the fixing holes to mount

(continued on next page)

(continued from previous page)

the board to the base of the case. I drilled three more holes through the board to allow fixing. The 0.25in. insulated spacers put space between the board and the base of the case.

I then wired up the key panel — see figure 2 for details. It was simply a matter of duplicating the linkage from both sides of the printed-board key panel. After ensuring that all of the adhesive had been cleaned away from the key panel, I soldered 13 wires of different colours into the original keys which went to the computer circuit.

These wires were then laced together and soldered to the appropriate switches on the new key panel. The board was then mounted into the case and wired to the appropriate switches and sockets. To allow the RAM pack to be plugged on to the edge connector, I found it necessary to cut the two feet from the bottom of the RAM case.

Round-headed nuts and bolts secured the key panel to the top cover. Before the cover was finally fitted, a small piece of sponge was positioned immediately above the RAM. This ensures that the RAM is held firmly in place.

Finally the keyboard template, supplied with the 8K ROM, was cut up into its individual letters and placed in position on the new key tops, the Perspex covers snapped into place and the job was complete.

Figure 1.

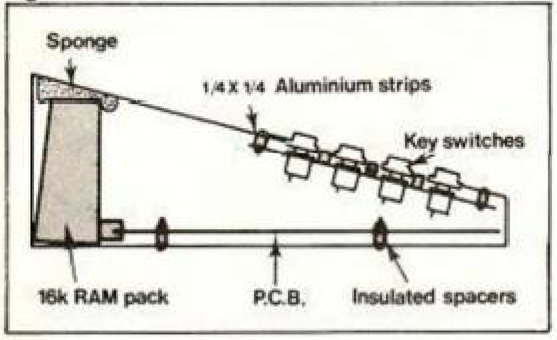
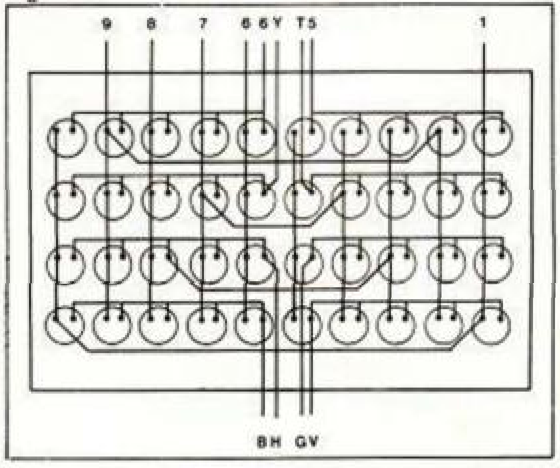


Figure 2.



Startling display

Anne Sarrag, London SE18.

GENIE

I WROTE THE following program for my Video Genie. It creates a startling display, not very predictable from the listing itself. Although it is not very useful, apart from producing moving graphics, it could be incorporated into a game.

```
10   FOR A%  =  155  TO 1 STEP - 1
20   FOR B%  =  15360 TO 16383 STEP A%
30   POKE B%    191
40   NEXT B%
50   CLS
60   NEXT A%
70   GOTO 10
END
Press BREAK to escape the program.
```

Alien search

R Lawrence, S Haigh, St Helier, Jersey.

ZX-81

ALIEN SEARCH uses most of the common functions of the ZX-81. The object of the game is to locate an alien starfighter within a force-field. The force-field strength determines the amount of shots — line 120 — and the hiding place — lines 150 to 170. That is, the larger the force-field strength, the harder the game. Your shots are put in as three co-ordinates, north, south and range, and line 330 determines if you hit the alien.

Laser guns may explode wasting shots or your battle computer may malfunction, causing the alien to move, hence you must start searching again.

These conditions are completely random and are determined in lines 675 to 700. The result of each shot is displayed by the subroutine lasers. The program ends with you hitting the alien or by running out of shots.

```
10   LET     LASERS = 500
20   PRINT   TAB 8; " "" ALIEN SEARCH"" ", TAB 39;
             "----------------" ,,, TAB 5; " "" R.
             LAWRENCE/S. HAIGH "" "
30   PRINT
40   PRINT
50   PRINT
60   PRINT   "YOU HAVE TRAPPED AN ALIEN","STAR-FIGHTER
             WITHIN YUR","FORCE FIELD.",,,,"YOU HAVE A
             DEFINED AMOUNT","OF LASER BOLTS TO SEEK",
             "OUT AND DESTROY HIM."
70   PRINT
80   PRINT
90   PRINT   "SET FORCE FIELD STRENGTH"
100  INPUT   S
110  CLS
120  LET     N = INT (5+RND*(S/4))
125  SCROLL
130  PRINT   "YOU HAVE "; N; " PRIMED LASER GUNS"
140  LET     D = 1
150  LET     A = INT(RND*S)
160  LET     B = INT(RND*S)
170  LET     C = INT(RND*S)
180  SCROLL
190  PRINT   "ATTEMPT ";D
200  SCROLL
210  PRINT   "INPUT ""NORTH-SOUTH"" "; TAB 23;
220  INPUT   X
230  PRINT   X
240  SCROLL
250  PRINT   "INPUT ""EAST-WEST"" ";TAB 23;
260  INPUT   Y
270  PRINT   Y
280  SCROLL
290  PRINT   "INPUT ""RANGE"" "; TAB 23;
300  INPUT   Z
310  PRINT   Z
320  SCROLL
330  LET     W = (X-A) OR (Y-B) OR (Z-C)
340  IF      W = 0 THEN GOTO 430
350  GOTO    670
360  GOSUB   LASERS
370  LET     D = D+1
380  IF      D>N THEN GOTO 400
390  GOTO    380
400  FAST
402  PAUSE   100
403  POKE    16437,255
405  CLS
407  SLOW
410  PRINT   TAB 12; "URGENT",,,"BATTLE COMPUTERS
             REPORT THAT","ALL LASER GUNS NOW
             FIRED ",,,"ALIEN STAR-FIGHTER HAS SHOWN"
             ,"ITSELF AT",,"NORTH-SOUTH ",A, "EAST-WEST",
             B, "DISTANCE",C,,,"BUT IT IS NOW ESCAPING"
420  STOP
430  IF      D = 1 THEN GOTO 470
440  SCROLL
450  PRINT   " ""BOOM""YOU TOOK ";D;" SHOTS"
460  STOP
470  SCROLL
480  PRINT   " ""BOOM"" YOU TOOK ";D;" SHOT"
490  STOP
500  REM     LASERS
510  SCROLL
520  PRINT   "LASERS ARE SET"
530  SCROLL
540  IF      X>A THEN PRINT "NORTH"
550  IF      X<A THEN PRINT "SOUTH"
560  IF      X = A THEN PRINT "NORTH-SOUTH O.K."
570  SCROLL
580  IF      Y>B THEN PRINT "EAST"
590  IF      Y<B THEN PRINT "WEST"
600  IF      Y = B THEN PRINT "EAST-WEST O.K."
610  SCROLL
620  IF      Z>C THEN PRINT "RANGE TOO LONG"
630  IF      Z<C THEN PRINT "RANGE TOO SHORT"
640  IF      Z = C THEN PRINT "RANGE O.K."
650  SCROLL
660  RETURN
670  SCROLL
675  RAND
680  LET     F = INT(RND * 30)
690  IF      F>4 THEN GOTO 360
700  IF      F>=0 AND F<=2 THEN GOTO 760
710  SCROLL
720  PRINT   "BATTLE COMPUTER MAL-FUNCTION"
723  SCROLL
727  PRINT   "ALIEN NOW RE-POSITIONING"
730  LET     D = D + 1
740  SCROLL
750  GOTO    150
760  SCROLL
770  PRINT   "LASER GUN "; D ;"HIT BY ALIEN STRIKE"
780  SCROLL
790  SCROLL
800  PRINT   "GO ON TO GUN ";D + 1
810  SCROLL
820  GOTO    370
```

Memory economy

S A Nicholls,
Keynsham, Bristol.

ZX-81

THIS PROGRAM demonstrates the memory saving which can be achieved on the ZX-81 1K. In its correct Basic form this program is too long to fit into 1K of memory. However, using codes in place of numbers where possible reduces the program length by 145 bytes and so enables it to run in 1K.

The program itself is not outstanding, but it does allow you to play a fair game of Oxo against the ZX-81 and is written without the need for machine-language routines.

The program is for 1K ZX-81 only. The computer has random 0 start — biased to the centre, and it will try to win. Decision time is less than five seconds. It gives an input prompt but will not accept occupied square inputs. It prints "Draw" after all squares are full, or, once stalemate is reached, after an X input. The computer can be beaten — there are two different win start positions.

```
1  REM ◘◘▒=*,ADG*◘G*▒A=A◘*◘D,▒G[R]$$0
POKE 16539,104
POKE 16540,122
2  PRINT "[1]□▒[2]□▒[3]□"
3  PRINT "▒▒▒▒▒▒▒▒"
4  PRINT "[4]□▒[5]□▒[6]□"
5  PRINT "▒▒▒▒▒▒▒▒"
6  PRINT "[7]□▒[8]□▒[9]□"
7  LET X = 16513
8  LET Q = PEEK 16396 + 256 * PEEK 16397
9  LET A = INT ( RND * CODE "/" + CODE "◘" )
10 POKE Q + PEEK (X+A), CODE "O"
11 FOR G = CODE "◘" TO CODE "◘"
12 PRINT AT CODE "◘", CODE "◘"; "◘GO◘"
15 INPUT A
16 PRINT AT CODE "◘", CODE "◘"; "■■"
17 LET B = PEEK (X+A)
18 IF PEEK (Q+B) <> CODE "□" THEN GOTO CODE "£"
19 POKE Q+B, CODE "X"
20 FOR A = CODE "◘" TO CODE "◘"
21 FOR B = CODE "◘" TO CODE "-" STEP CODE "◘"
25 IF PEEK(Q + PEEK (X+B)) + PEEK ( Q + PEEK(X+B + CODE "◘" ))
     + PEEK(Q + PEEK (X + B + CODE "◘"))<> PEEK(X + A + CODE "/" )
     THEN GOTO CODE "F"
34 FOR C = CODE "□" TO CODE "◘"
36 LET S = Q + PEEK (X+B+C)
38 IF PEEK S = CODE "□" THEN GOTO CODE "M"
40 NEXT C
41 PRINT "YOU WIN"
42 STOP
43 NEXT B
44 NEXT A
45 GOTO CODE "Q"
50 POKE S, CODE "O"
51 IF A = CODE "◘" THEN GOTO CODE "S"
52 NEXT G
54 PRINT "DRAW"
55 STOP
56 PRINT "I WIN"

Space = □
Inverse chrs. in boxes, [R] = inv.R      ▒ = Graphics shift A
Where possible numbers have been replaced by codes to save memory
eg. CODE "/" = 24  saves 5 bytes
```

Moonlander

C Butler,
Prittlewell, Essex.

ZX-81

IN THIS PROGRAM you have to land your space craft in a crater on the lunar surface without running out of fuel. You appear at a random position above the moon, and to fire your main descent rocket press "S" — a pleasing jet of flame will burst out from beneath you.

To move left and right press "A" and "D" respectively. To obtain a successful landing you must manoeuvre your craft over the crater — a grey rectangle — at a sufficiently slow speed. The computer acknowledges your success and displays the amount of fuel left. After a short pause you may start a new game.

You start with 200 fuel units and each time the main rocket is fired five units are lost. A left or right manoeuvre results in a unit loss of fuel.

The string in line 39 is a combination of the graphics found on keys "WQWQ6Q6ASSSA6WQQWY6" and the character in line 9520 is a left arrow. Line 55 should read IF H <20.

```
0 REM MOONLANDER
1 PAUSE 100
5 LET F=200
10 LET X=INT(RND*36)
20 LET H=20
30 LET S=0
38 CLS
39 PRINT AT 20,0;"..."
40 PLOT X,H
41 PLOT X+1,H
45 IF F>0 THEN IF INKEK$="S" THEN GOSUB 1000
48 IF F>0 THEN IF INKEY$="D" THEN GOSUB 9520
49 IF F>0 THEN IF INKEY$="A" THEN GOSUB 9560
55 IF H>4 THEN GOTO 4000
60 LET H=H-S
65 KET S=S+0.1
70 IF H>20 THEN LET H=20
90 GOTO 38
1000 LET S=S-0.2
1010 LET F=F-5
1020 PRINT TAB 32+X/2;"V"
1050 RETURN
4010 PRINT AT 15,0;
5000 IF S<0.3 THEN PRINT "GREAT"
5040 IF S>=0.3 OR X<16 OR X>21 THEN PRINT "SMASH"
5050 PRINT "FUEL=";F
9510 GOTO 0
9520 PRINT AT 20-H/2+1,X/2-1.5;"<"
9530 LET X=X+1
9540 LET F=F-1
9550 RETURN
9560 PRINT ">"
9570 LET X=X-1
9580 LET F=F-1
9600 RETURN
READY.
```

Cricket score

M Fox,
Walsall, West Midlands.

ZX-81

THIS PROGRAM is designed to run on a Sinclair ZX-81 with the 16K RAM pack. The program displays a cricket scoreboard and has many built-in features. The variables are,

O = overs; W = wickets; S = batting strike; BS = bowling strike; E = extras; L$(W) = fall of wickets; B(1) and B(2) are the batsmen scores; A$ = last man; X$ and Y$ are bowlers; B$ and C$ are batsmen; R = runs, L$ = last stand.

It is advisable to Goto 5000 for the start of each match.

When the program is in use, enter: 1,2,3,4,6 for the runs scored, 7 for the end of an over, 0 for a change of bowler — the computer will input a new name for the bowler with the strike — 5 for leg-byes and byes then enter the number of byes scored, 8 for a normal extra, 9 for a wicket. The computer will input the new last man, the new batsman's name — it takes the batsman with the strike — and if 50 is entered, any one of the following keys pressed will make the computer print the sign following:

L = lunch; T = tea; S = stumps; R = rain; B = bad light; D = drinks; N = new ball; E = erase.

Where "£" appears in the program, use a black graphics space. From 1000 to 4000, space is left for the user's own score cards and these can be assessed by Goto 2 then inputting the number 1 to 4 as appropriate. To obtain the normal score-board then use Goto 4.

When the 10th wicket falls, the computer will input a new last man, print this and then input any number before resetting for the next innings. For the 1K version of this program the variables are:

R = runs; W = wickets; O = overs; E = extras; A$ = last man; B$ and C$ are the bowlers; and LW = last wicket.

Enter 1,2,3,4,5,6 for runs scored, 7 for the end of an over, 8 for an extra, and 9 for a wicket — the computer will input the last man. A bowling change must be done by stopping the program and changing the variable manually.

(continued on page 65)

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(continued from page 63)

```
   1 REM "TEST"
   2 INPUT Z
   3 GOTO Z*1000
   4 GOSUB 890
   5 PRINT AT 0,1;B$;B(1),C$;B(2)
   7 PRINT
  10 PRINT R; "RUNS"
  20 PRINT "FOR ";W;" WICKETS"
  25 PRINT
  30 PRINT "ENGLAND LEAD BY ";153+R
  40 PRINT 0;" OVERS"
  50 PRINT "EXTRAS"; E
  60 PRINT "LAST MAN:"
  65 IF W= 10 THEN GOTO 350
  67 PRINT A$
  70 IF LEN A$<32 THEN PRINT
  80 PRINT "BOWLERS:"X$,,Y$
  81 PRINT
  82 IF W<>0 THEN PRINT AT 21,8; "LAST STAND ";LS
  84 IF W<>0 THEN PRINT AT 20,8;"THIS STAND ";R-VAL L$ (W)
  88 PRINT AT 12,0;"£"
  95 INPUT Z
  99 IF Z = 9 AND W=9 THEN GOTO 300
 100 IF Z = 9 THEN GOTO 200
 101 IF Z = 5 THEN GOTO 600
 103 IF Z = 0 THEN GOTO 500
 105 IF Z = 8 THEN GOTO 150
 107 IF Z = 7 THEN GOTO 130
 109 IF Z =50 THEN GOTO 440
 110 LET R=R+Z
 115 LET B(S)=B(S)+Z
 117 IF Z = 1 OR Z = 3 OR Z=-1 OR Z=-3 THEN GOTO 225
 120  GOTO 5
 130  LET O=O+1
 140  GOTO 9000
 150  LET E=E+1
 160  LET R=R+1
 170  GOTO 5
 205  LET W=W+1
 207  IF W=1 THEN LET LS=R
 208  IF W<>1 THEN LET LS=R-VAL L$(W-1)
 210  INPUT A$
 215  LET L$(W)=STR$ R
 217  LET B(S)=0
 219  IF S=1 THEN INPUT B$
 220  IF S=2 THEN INPUT C$
 223  GOTO 4
 225  IF S=1 THEN GOTO 400
 230  LET S=1
 235  PLOT 0,43
 240  UNPLOT 30,43
 245  IF A=1 THEN RETURN
 250  GOTO 5
 300  LET W=W+1
 305  INPUT A$
 310  GOTO 5
 350  INPUT Z
 360  GOTO 5000
 400  LET S=2
 403  PLOT 30,43
 407  UNPLOT 0,43
 408  IF A=1 THEN RETURN
 410  GOTO 5
 440  IF INKEY$="" OR INKEY$=CHR$ 118 THEN GOTO 440
 442 IF INKEY$="T" THEN LET H$="TEA"
 443 IF INKEY$="S" THEN LET H$="STUMPS"
 444 IF INKEY$="R" THEN LET H$="RAIN"
 445 IF INKEY$="B" THEN LET H$="BAD LIGHT"
 446 IF INKEY$="N" THEN LET H$="NEW BALL"
 447 IF INKEY$="D" THEN LET H$="DRINKS"
 448 IF INKEY$="E" THEN LET H$= "#########"
 458 PRINT AT 3,16;H$
 460 GOTO 5
 500 INPUT Z$
 510 IF BS = 1 THEN LET X$=Z$
 530 IF BS = 2 THEN LET Y$=Z$
 540 GOTO 4
 600 INPUT Z
 605 LET E=E+Z
 610 LET R=R+Z
 620 IF Z=1 OR Z=-1 OR Z=3 OR Z=-3 THEN GOTO 225
 630 GOTO 5
 900 FOR N=0 TO 21
 910 PRINT AT N,0; "################################"
 920 NEXT N
 930 GOSUB 6000
 940 RETURN
4990 STOP
5000 LET W=0
5010 LET R=0
5015 CLS
5020 LET O=0
5030 LET E=0
5040 LET A$=""
5042 LET S=1
5047 LET BS=1
5050 PRINT "BATSMAN?"
5060 INPUT B$
5080 INPUT C$
5090 DIM B(2)
5100 DIM L$(10,3)
5110 PRINT "BOWLERS?"
5120 INPUT X$
5130 INPUT Y$
5140 GOTO 4
6000 PRINT AT 14,0;"FALL OF WICKETS"
6100 LET A=2
6110 RETURN
9010 IFBS=1 THEN GOTO 9060
9020 LET BS=1
9030 PLOT 30,21
9040 UNPLOT 30,90
9050 IF A=1 THEN RETURN
9055 GOTO 255
9060 LET BS=2
9070 PLOT 30,19
9080 UNPLOT 30,21
9090 IF A=1 THEN RETURN
9100 GOTO 225
```

```
   5 REM"TEST"
  10 PRINT AT 0,0;R;" RUNS"
  20 PRINT W;" WICKETS"
  30 PRINT "RUNS REQUIRED ";R-130 (OR ENGLAND LEADS BY)
  40 PRINT O;" OVERS"
  50 PRINT "EXTRAS ";E
  60 PRINT "LAST MAN";A$
  70 PRINT "LAST WICKET ";LW
  80 PRINT "BOWLERS;", B$,,C$
  90 INPUT Z
 100 IF Z=9 THEN GOTO 200
 105 IF Z=7 THEN GOTO 130
 107 IF Z=8 THEN GOTO 150
 110 LET R=R+Z
 120 GOTO 1
 130 LET O=O+1
 140 GOTO 1
 150 LET E=E+1
 160 LET R=R+1
 170 GOTO 1
 200 LET W=W+1
 210 INPUT A$
 215 LET LW=R
 220 GOTO 1
```

= pound sign

Writing wrongs

D Lawrence,
Highfield, Southampton.

ZX-81

JAMES TYLER'S RENUMBER routine published on page 67 of your November 1981 issue is a neat piece of work but it has the slight disadvantage that it will not run on a ZX-81.

The reason is simple. In designing the program, James Tyler has assumed that the end-of-file indicator for a Basic program consists of the Newline of the last program line plus two more halt codes — 119. He also apparently believes that in the absence of a Basic program, memory addresses 16509 and 16510 — the normal location of the first line number — are loaded with 118. Unfortunately, he is wrong on both counts.

In the absence of a Basic program only 16509 is set to 118 and the end-of-file indicator is the Newline of the final program line followed by one halt. The routine never finds the end of program indicator it is seeking and goes on searching up the memory until it crashes.

The answer to the problem is to shorten the routine by removing one of the loops which examine addresses for a halt. Thus, in the absence of a Basic listing, the routine returns to Basic on finding a single 118 at address 16509 or, if there is a Basic program, on finding two consecutive 118s at any given point.

In addition to these necessary changes given my version, the original loading programs are unnecessarily complex for a machine-code routine of this length. Instead of two consecutive programs, my Basic program will suffice and, in addition, make the editing of any mistakes far more simple.

An optional

425 PRINT (S + (I-1)/3), PEEK (S + (I-1)/3)

will display the address and what has been loaded there.

The procedure is as follows: lower RAM-top the number of bytes necessary by Poking

(continued on page 67)

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(continued from page 65)
16388,229 and 16389,127 — 1K:67. Then enter New to reset RAMtop and enter the Basic program and save it — just in case anything goes wrong.

Run the program and the code will be inserted above RAMtop. The start address is 32741 — 17381:1K. If you have made some error in the code, simply reload the program — always assuming that RAMtop is still where you want it — and edit the string, remembering that each decimal value should occupy three spaces.

Delete the Basic program and the routine will renumber anything you care to enter, on the command

PRINT USR 32741 -- 1K:17381

The method saves seven bytes on the machine code, nine lines of Basic and the string occupies less space than the suggested numerical array.

```
DECIMAL        HEX         INSTR          COMMENTS

33,125,64      21,7D,40    LD HL,407D     ;address of first line number
17,10,00       11,0A,00    LD DE,0A       ;desired first line number in DE
126            7E          LD A, (HL)     ;is it a halt
254,118        FE,76       CP 76
200            C8          RET Z          ;if so return to Basic
114            72          LD (HL),D      ; load new line number
35             23          INC HL
115            73          LD (HL),E
6,10           06,0A       LD B,0A        ;create next line number
19             13          INC DE
16,253         10,FD       DJNZ
35             23          INC HL         ;test for end of program line
126            7E          LDA,(HL)
254,118        FE,76       CP X 76
32,250         20 FA       JRNZ
35             23          INC HL         ;move to next possible line
number
24,235         18,EB       JR             ;jump to next check

100 LET C$="03312506401701000012625411820011403511
    500601001901625303512625411803225003502423 5" (the decimal code
gien)
200 PRINT "START ADDRESS?"
250 INPUT S (New RAMTOP address)
300 FOR I=1 TO LEN C$ STEP 3
350 LET C=VAL C$(I TO I+2)
400 POKE (S+(I-1)/3),C
450 NEXT I
```

Key to understanding

R J Fernandez,
Montrose, Angus.

ATOM

A SIMPLE, 2.5K Basic disassembler has helped me uncover some of the operating-system routines which read the Atom keyboard. The first problem I encountered is the absence of a keyboard Get command — not the Get byte cassette command. This is easily overcome using a simple machine-code routine — as easy as Basic if you use the excellent Atom disassembler.

The following routine uses the OSEcho routine at #FFEbH and stores the ASCII value at #80H.

```
20 Eb FF  JSR# FFEb ; Get key into the
                      accumulator
85 80     STA# 80   ; Store code at 80H
60        RTS
```

The character can be removed using:

$A = $ (?# 80)

where $A is a previously dimensioned string variable. It would be easier just to consider the code when deciding which key was pressed, e.g.,

IF ?# 81 = CH"A"

A more annoying problem, however, is to read a key without stopping the program — one of the problems of a keyboard which is not buffered. However, there is a routine in ROM used by the OSRDCH or read-character routine which returns the position of the depressed key on the keyboard matrix — figure 1.

The routine at #FE71H returns in the Y register the position of the key on the matrix counting from SP which is position 0, through A which is position 33D, to ESC at position 59D. Register X contains the row number #1 of the depressed key and the accumulator contains a value corresponding to the bit position of possibilities — multi-player games on the same keyboard, multiple actions simultaneously in a game and so on.

Bit Position

		7	6	5	4	3	2	1	0
Bit position values	HEX	80	40	20	10	8	4	2	1
	DEC	128	64	32	16	8	4	2	1

The boxes contain the values associated with each bit.

Figure 2. Bit values

A final warning — if you try to write the routine in Basic, all the keys in column 5 act as the ESC key during the scan, and stop the program if one of them is depressed.

While working in ROM, I discovered several of the routines and tables used by the system software and I have included some of the addresses in table 1.

The following routine can be used to build up the keyboard bit map:

Op-codes Label Mnemonics

```
A2 09               LDX1M# 9; Load counter
8A         : LLI    TXA
18                  CLC
6D 00 B0            ADC # B000}; Drive key-
8D 00 B0            STA # B000}  board row
AD 01 B0            LDA # B001; Read row
95 80               STA # 80, X
A9 F0               LDAIM# FO}  Zero lower
2D 00 B0            AND # B000}; nybble of
8D 00 B0            STA # B000}  Port A
CA                  DEX
10 E9               BPL LL1; Finished?
60                  RTS
```

Once a bit map of the keyboard has been made, it is a simple matter to check for any key: take its row value and And it — using the logical bitwise And command in Basic — with the value corresponding to the key bit

(continued on page 69)

(continued from page 67)
position. See figure 2 for these bit values.

If the result of the And operation is 0, the key is being pressed. Bits 6 and 7 of all these key row values represent the conditions of the control and shift keys at the time of the scan — that is, if the value is less than 128D then shift is pressed; if less than 192D, CTRL is pressed.

For example, to check if A is pressed, after running the routine, do the following from Basic:

- Consider the value at # 83H — row 3.

Figure 1. The keyboard matrix.

Row number \ Bit position	0	1	2	3	4	5
9		3	—	G	Q	ESC
8		2	,	F	P	Z
7		1	;	E	O	Y
6		0	:	D	N	X
5	Lock	DEL	9	C	M	W
4		COPY	8	B	L	V
3	]	RET	7	A	K	U
2			6		J	T
1	[		5	/	I	S
0	SP		4	.	H	R
Column number	0	1	2	3	4	5

Note: Read column number then row number for position code in Y after routine at # FE71H. E.g., A = 33D.

- And value with 8D — bit position 3, column 3.
- If result 0, key is pressed.
- Check if control or shift are pressed as described, if necessary.

This approach to reading the keyboard opens a whole new range of key-column reading from column 0 which corresponds to bit 0, to column 5 which corresponds to bit 5. For example, if the A key is depressed register Y = 33, register X = 4 and Acc = 8 — i.e., column 3.

The following machine-code routine reads the keyboard and stores the Acc, X and Y in # 80E, # 81H and # 82H respectively, although only the Y register value is actually needed to find the depressed key.

```
20 71 FE   JSR# FE71
85 80      STA# 80
86 81      STX# 81
84 82      STY# 82
60         RTS
```

Note that the values are unaffected by shift and control, so to check for a shifted key, the value at B001D is less than 128D, and for a control key the value is less than 192.

If only an alphabet or number key, or for that matter any key with ASC11 code between # 30H and # 5AH, is being checked, the ASC11 code can be obtained by adding 14D to the value in the Y register. The one problem with the second routine is that only one key can be read at a time. This can be solved by using a small routine to make a bit map of the keyboard matrix.

The basic idea is to store the numbers 1 to 10D in sequence in the lower nybble of # B000D — port A of the 8255 PPIA — to drive each row of the matrix in turn and each time read the value at port B, which corresponds to the keyboard column, and store this in a buffer area to be looked up by the calling program.

Each of the 10 row values is stored in one byte, thus the whole keyboard requires only 10 bytes. My own preference is to use the memory between # 80H and # AF in zero page which is free.

Table 1.

# FDECH	— Scroll routine. Fill the screen with characters and try LINK# FDEC. LDY@0; JSR# FE16 produces half screen scroll.
# FE6BH	— Screen synchronisation routine.
# FD1AH	— CTRL-G routine.
# FD0BH	— Start screen, ACK routine.
# FD11H	— Page mode off, S1.
# FD0BH	— ESC routine.
# FF3FH	— RES routine.
# C9D8H	— Reset service routine.
# C9EYH	— Basic error routine.
# C000H	— Base of command table.
# D000H	— Base of FP command table.
# F000H	— Base of command table.
# F8BEH	.— Base of command table.

The # represents hexadecimal; the @ immediate mode or Atom standard.

Screen print

N Higham,
Eccles, Manchester.

PET

THIS PROGRAM for all Pets — except old ROM — prints the contents of the screen on a Commodore 3022 or 4022 printer. When loaded, or appended to an existing program and called by Gosub 63000, the screen is dumped to the printer in the centre of the paper and surrounded by a box.

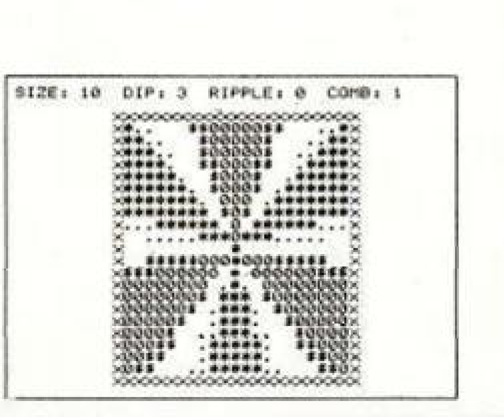
The routine is intelligent in that it executes a delay, the length of which depends linearly on the amount of reverse-field characters on the line just printed. This is to avoid the print head burning out if the screen contains a large amount of reverse field.

Line 63010 reduces the line spacing to give vertically contiguous graphics and line 63130 resets it. The printing can be halted at any time by pressing 'S' and restarted by pressing any key.

Line 63075 allows for a bug in the 4022 printer in that CHRS(254) prints a space instead of the required graphics character.

```
63000 REM ---- 'SCREENPRINT'  BY  N.J.HIGHAM ----
63005 REM  PRESS 'S' TO HALT PRINTING, ANY KEY TO RESTART
63007 CLR:P1=24:P2=36:REM FOR 4022
63008 REM FOR 3022 P1=18:P2=24
63010 OPEN6,4,6:PRINT#6,CHR$(P1):CLOSE6:PRINT"▒"
63020 T=18:Z$="┌":FORI=1TO40:Z$=Z$+"‾":NEXT:OPEN4,4:PRINT#4,TAB(T)Z$"┐"
63030 PRINT#4,TAB(T)"| ";:DEFFND(X)=-(R>5)*(2000+400*X)
63040 E=33767:FORI=32768TOE:A=PEEK(I)
63050 GETA$:IFA$="S"THENPOKE158,0:WAIT158,1:GETA$:POKE158,0
63060 IFF=0ANDA>127THENF=1:PRINT#4,CHR$(T);:GOTO63075
63070 IFF=1ANDA<128THENF=0:PRINT#4,CHR$(146);
63075 IFA=254THENB$="*":GOTO63100
63080 B=-(A+64)*(A<64)-(A+128)*(63<AANDA<126)-(A+64)*(125<AANDA<128)
63090 B=B-(A-64)*(127<AANDA<191)-A*(190<AANDA<255)-191*(A=255):B$=CHR$(B)
63100 R=R+F:PRINT#4,B$;:X=X+1:IFX<40GOTO63120
63110 FORD=1TOFND(R):NEXT:R=0:X=0:F=0:PRINT#4,"■ |":IFI<ETHENPRINT#4,TAB(T)"| ";
63120 NEXT:Z$="L":FORI=1TO40:Z$=Z$+"_":NEXT:PRINT#4,TAB(T)Z$"┘":PRINT#4:CLOSE4
63130 OPEN6,4,6:PRINT#6,CHR$(P2):CLOSE6
63200 OPEN4,4:PRINT"▒RETURN■: P/FEED":PRINT"▒SPACE■:  END
63210 A=PEEK(151):IFA=27THENPRINT#4
63220 IFA=6THENCLOSE4:POKE158,0:END
63230 GOTO63210
```





Storage technique

John Eade,
Stroud, Gloucestershire.

ZX-81

THE FREE-MEMORY routine by Paul Brittain, November 1981 page 67, is intended for use when writing programs. It must not hamper the program being written. If it is stored in a Rem statement in the first line, it will change all program addresses when finally deleted. In any case, there may be another machine-code routine which must occupy that position because of the absolute addresses within it.

There is, however, another way of storing machine-code routines which I have not seen mentioned elsewhere. This is simply to Poke it into any program line Rem statement and call it from the previous line using the NXTLIN variable — see ZX-81 manual page 178. Enter the two lines as follows:

```
9989 LET A = (PEEK 16425 + 256 × PEEK
     16426 + 5)
9990 REM XXXXXXXXXXXXXXXXXXXXX
     (that is 21 Xs)
9991 FOR N = A TO A + 21
9992 INPUT B
9993 POKE N,B
9994 PRINT PEEK N
9995 NEXT N
GOTO 9989
```

Enter: 175, 103, 111, 57, 237, 75, 28, 64, 237, 66, 229, 193, 253, 33, 0, 64, 62, 30, 237, 71, 201

Delete lines 9991, 9992, 9993, 9994, 9995

Edit line 9980 — delete LET A = and substitute PRINT USR

Do not forget to run the whole program if you can, so that the display file — if RAM is greater than 3.25K — and variables take the required space.

(continued on next page)

(continued from previous page)

Cost price

Ian McAlpine, Portadown, County Armagh.

ZX-81

I AM 14 YEARS old, and my father and mother have a do-it-yourself and crafts shop which sells many small items. After buying any stock, they have to estimate their mark-up and VAT and, finally, the selling price of each one.

My father had set his heart on proving that a calculator is faster than my Sinclair ZX-81, so I set out to prove him wrong. After buzzing around the keyboard for a few hours, I produced Cost Price.

The program first asks you to input the cost price. If it was 50p, then you would input 0.50, or if the cost price was £6.72 you would input 6.72. Then you are asked to input your required mark-up. You would input 1 for 50 percent, 2 for 60 percent, 3 for 75 percent, or 4 for 100 percent.

These percentages can be easily changed to suit your own requirements. Finally, you are asked to input the quantity. The computer then prints out the original cost price, on the left-hand side of the screen, and in the middle it prints the price at which you should sell each one, including your mark-up, and VAT.

When you input the cost price, you do not need to input the VAT, as the computer calculates the VAT for you, and includes it on to the recommended selling price. After about seven seconds, the computer returns to ask you to input the cost price again.

When I showed this program to my father, he threw his calculator in the bin. This program will run on an unexpanded ZX-81. The delay, before returning to the original question again, can be shortened or lengthened, by adjusting the Pause on line 160.

```
  4  REM COST PRICE
  5  PRINT "PLEASE INPUT COST PRICE"
 10  INPUT E
 12  IF E<=0 THEN GOTO I0
 15  CLS
 20  PRINT "MARK UP, 1=50;2=60;3=75;4=100"
 30  INPUT F
 31 CLS
 32 PRINT "INPUT QUANTITY"
 35 INPUT G
 37 CLS
 40 LET A=(E/2+E)/20*3
 50 LET B=(E/5*3+E)/20*3
 60 LET C=(E/4*3+E)/20*3
 70 LET D=(E+E)/20*3
 80 IF F=1 THEN GOTO 120
 90 IF F=2 THEN GOTO 130
100 IF F=3 THEN GOTO 140
110 IF F=4 THEN GOTO 150
120 PRINT "£";E,"£";(E+E/2+A)/G
125 GOTO 160
130 PRINT "£";E,"£";(E+E/5*3+B)/G
135 GOTO 160
140 PRINT "£";E,"£";(E+E/4*3+C)/G
145 GOTO 160
150 PRINT "£";E,"£";(E+E+D)/G
160 PAUSE 350
170 CLS
180 GOTO 5
```

Wild dogs

C D Carter, Bargoed, Mid Glamorgan.

ZX-81

THIS, MY FAVOURITE program, makes use of the fact that a computer can make logical movements. It uses these movements to make a very authentic chase-type game. The program makes full use of plot and unplot and simple calculation Basic.

The game is relatively easy to play and starts by putting you roughly in the centre of the screen. When you are confident enough to manage the arrow movement keys and hit the correct one very time, you press the Newline key. The computer will put its two characters on the screen. These characters will the move towards you, and it is then up to you to dodge them. You have a slightly faster speed than them.

When one of them thinks he is starting to catch you, he will accelerate. You still have the advantage while travelling in a straight line. When the game has finished, it will give you a rough estimate of the time you lasted in seconds, before being caught.

```
1     LET Q=60
2     LET W=40
3     LET CC=0
5     LET X=2
6     LET Y=X
10    LET A=20
20    LET B=A
21    PRINT AT 10,10;"WILD DOGS"
22    PAUSE 100
23    CLS
24    PLOT A,B
25    INPUT A$
30    LET A$=INKEY$
40    UNPLOT A,B
50    IF A$="5" THEN LET A=A-3
60    IF A$="6" THEN LET B=B-3
70    IF A$="7" THEN LET B=B+3
80    IF A$="8" THEN LET A=A+3
90    PLOT A,B
95    GOSUB 105
97    GOSUB 200
98    LET CC=CC+1
100   GOTO 30
105   UNPLOT X,Y
110   IF B>Y THEN LET Y=Y+2
120   IF A>X THEN LET X=X+1
130   IF A<X THEN LET X=X-2
140   IF B<Y THEN LET Y=Y-1
150   IF X=A AND Y=B THEN GOTO 300
160   PLOT X,Y
170   RETURN
200   UNPLOT Q,W
210   IF A>Q THEN LET Q=Q+2
220   IF B>W THEN LET W=W+1
230   IF A<Q THEN LET Q=Q-1
240   IF B<W THEN LET W=W-2
250   IF Q=A AND W=B THEN GOTO 300
260   PLOT Q,W
270   RETURN
300   PRINT AT 13,0;"YOU LASTED"; INT(CC/1.89);" SECS BEFORE THE"
310   PRINT AT 14,6;"WILD DOGS CAUGHT YOU"
```

External inputs

Ian McLean,
Preston, Lancashire.

ZX-81

THE ZX-81 KEYBOARD works on an X, Y grid system — see figure 1 — and does not require an electrical pulse, merely a connection between the X and Y terminals. A list of connections is given in table 1, and the terminals in figure 2.

For me, a port represented a programming and memory problem. My ideas require no

A=5,D	K=3,G	U=2,E	4=2,A
B=1,H	L=4,G	V=1,F	5=1,A
C=2,F	M=3,H	W=4,B	6=1,C
D=2,F	N=2,H	X=3,F	7=2,C
E=3,B	O=4,E	Y=1,E	8=3,C
F=2,D	P=5,E	Z=4,F	9=4,C
G=1,D	Q=5,B	0=5,C	. =4,H
H=1,G	R=2,B	1=5,A	newline=5,G
I=3,E	S=4,D	2=4,A	space=5,H
J=2,G	T=1,B	3=3,A	shift=5,F

Table 1.

software changes to existing programs, and only a small hardware connection to the connector inside the machine. The possibility of using a light-pen, temperature monitor, Space Invader-type hand-held controls and keyboard at the same time opened an exciting door into the world of interactive computing.

Inkey$ and sometimes Input can be used. I found that Inkey$ was the best for the controls in games like Meteors on the Sinclair games cassette 1. Inkey$ was used for the temperature monitor which triggers at a pre-set temperature, and can, under software control,

Quantity	Component
1	metre ribbon cable — 20 core
2	IL75 opto isolators
4	BC107/8/9 transistors
1	piece of veroboard
1	ORP12 photo-resistor
1	TH3 thermosistor
2	220K pre-set potentiometer
1	Low-power soldering iron
1	length of solder
1	pair of wire strippers

Table 2 above, and below, figure 4.

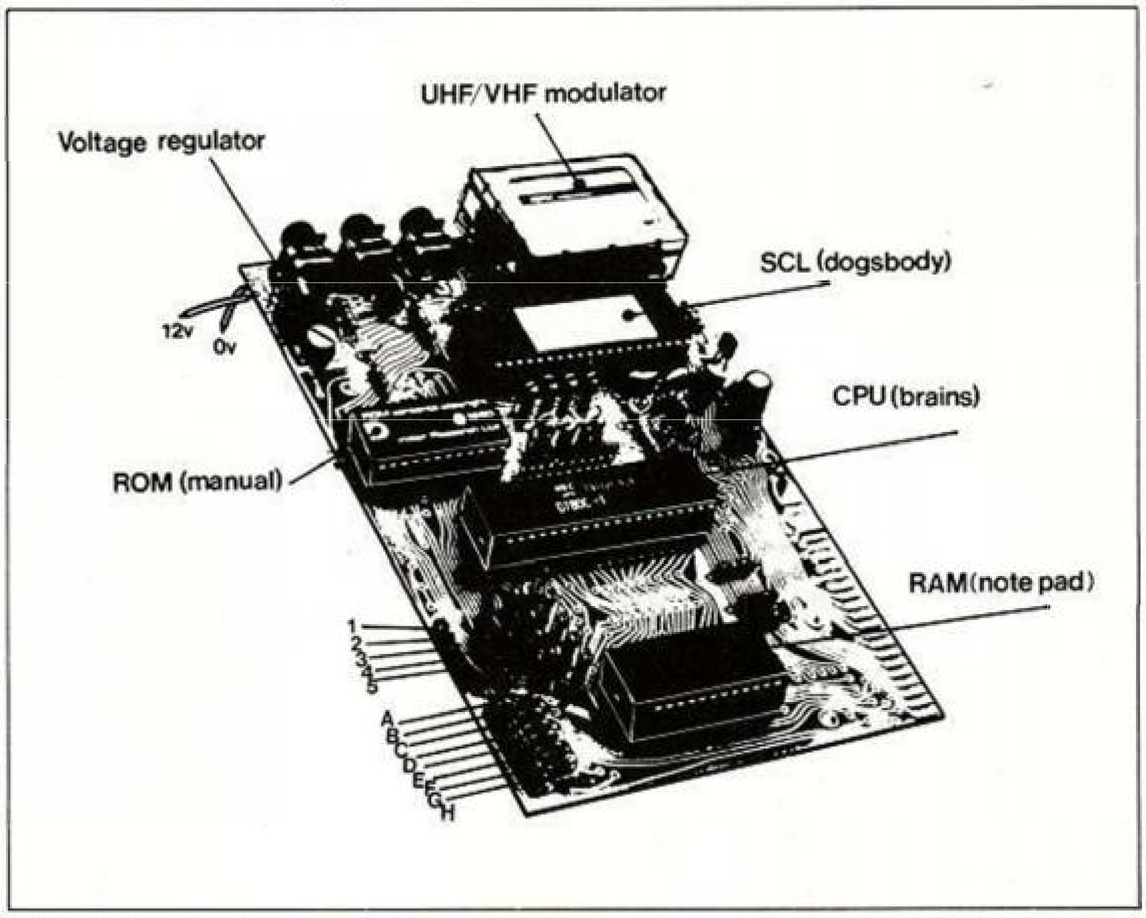
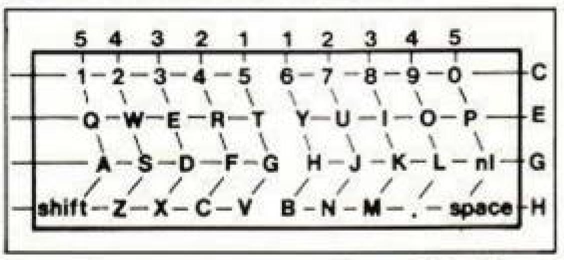


Figure 2 above, and below, figure 1.



be used as a temperature alarm. Inkey$ was also used for the light-pen to monitor the string input to see when the button was pressed and the value entered.

Input was found useful in separating keyboard and peripheral data. Because Input requires Newline after it, I did not connect Newline to the peripherals to avoid entering data accidentally. Even in this state, unwanted data could still be entered on to the screen.

As the Input statement only requires data during its execution, any data at the input immediately before its execution can automatically be rejected. In listing 1, line 20 does this. It waits for a clear input bus before allowing the Input statement to continue. Table 2 lists the tools and components required. The more experienced may wish to modify the hardware to his specific requirements.

Figure 3 gives the circuit diagrams for the push buttons, light-pen and temperature monitor. Note that the connections are not given, as different Inkey$ values may be allocated to each switch. Figure 4, however, shows the connections I made, as an example.

Figure 2 shows the necessary internal con-

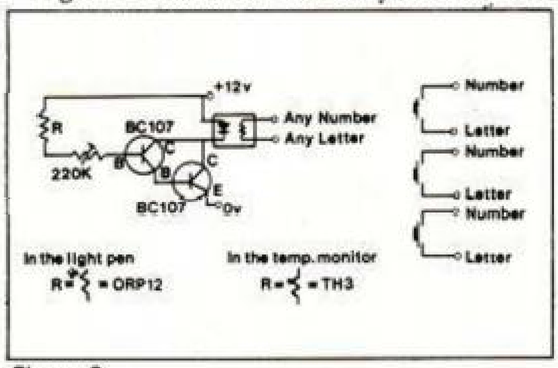
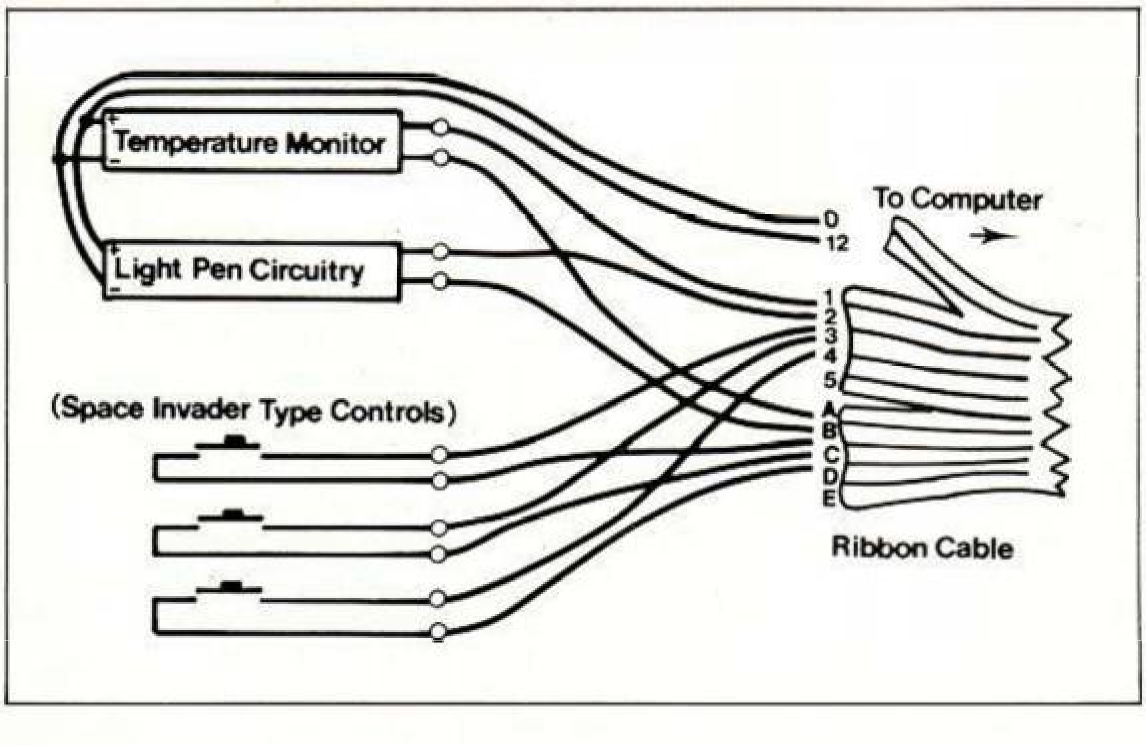


Figure 3.

nections inside the machine. The ribbon cable is soldered on to the copper side of the printed-circuit board to retain the keyboard connection on the component side. On the 1K version, two of the wires were connected to the 12V and 0V lines. It is helpful to make a note of the cable connections and corresponding colour codes for future reference. Pass the cable underneath the extra memory connector at the back and out through the hole.

Veroboard or a home-made board can be used to build the circuits and so the connection at the other end of the cable is entirely at the builder's discretion. My light-pen was built on a board with the photo-resistor in the end of a thick pen. The button is pressed when a reading is required. Software techniques enable signal inversion and screen scanning.

I would advise you to use an external power supply if the machine has any form of memory expansion, as a simple precaution. It is otherwise safe to make the specified connections on a 1K machine. ■



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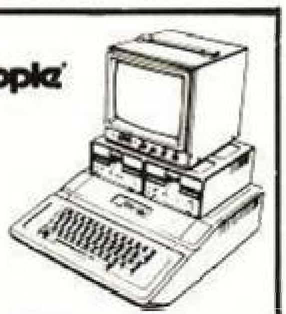
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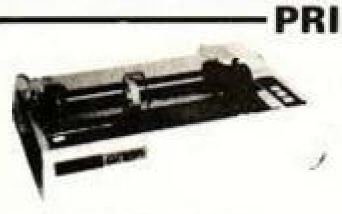
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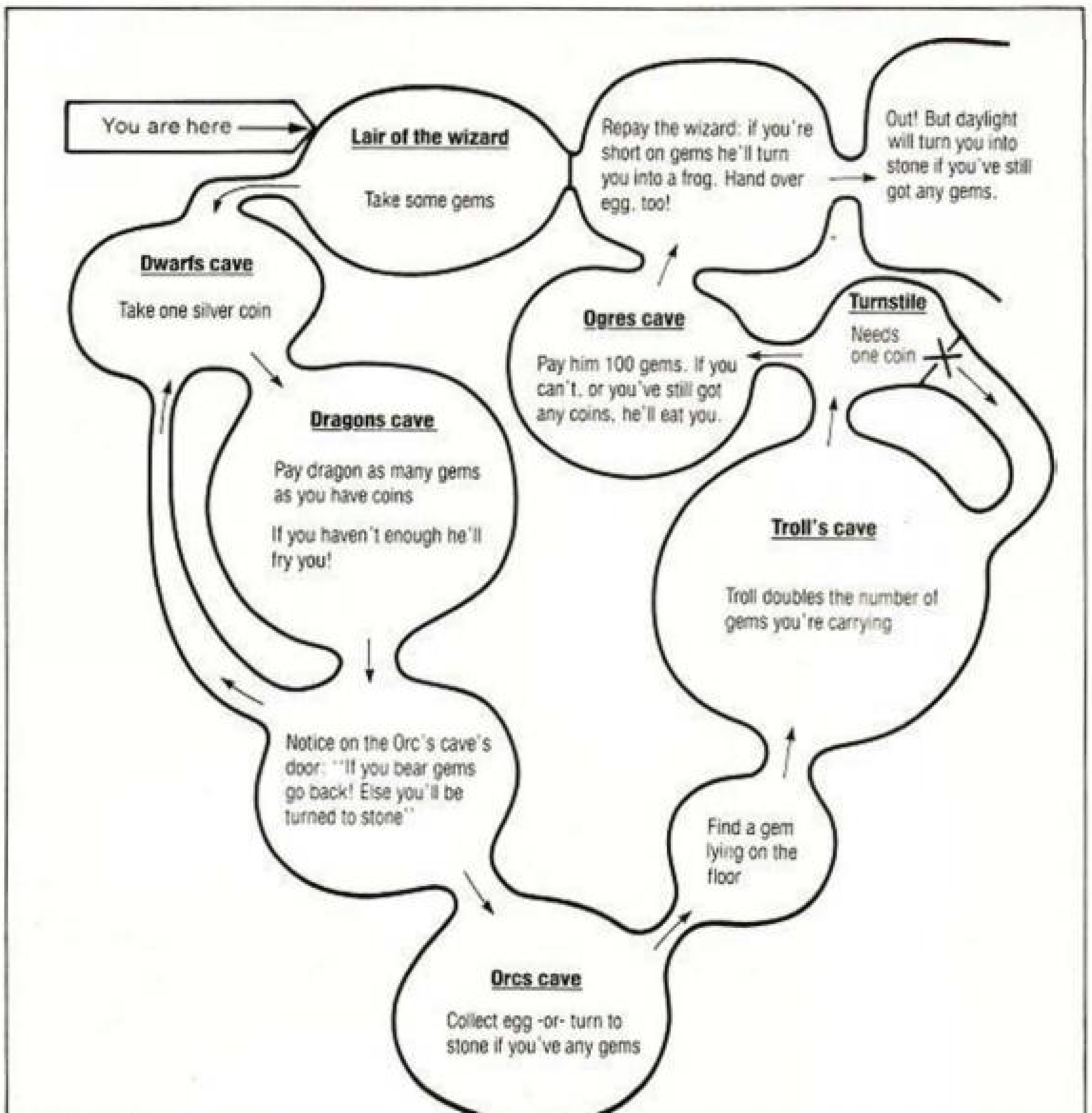
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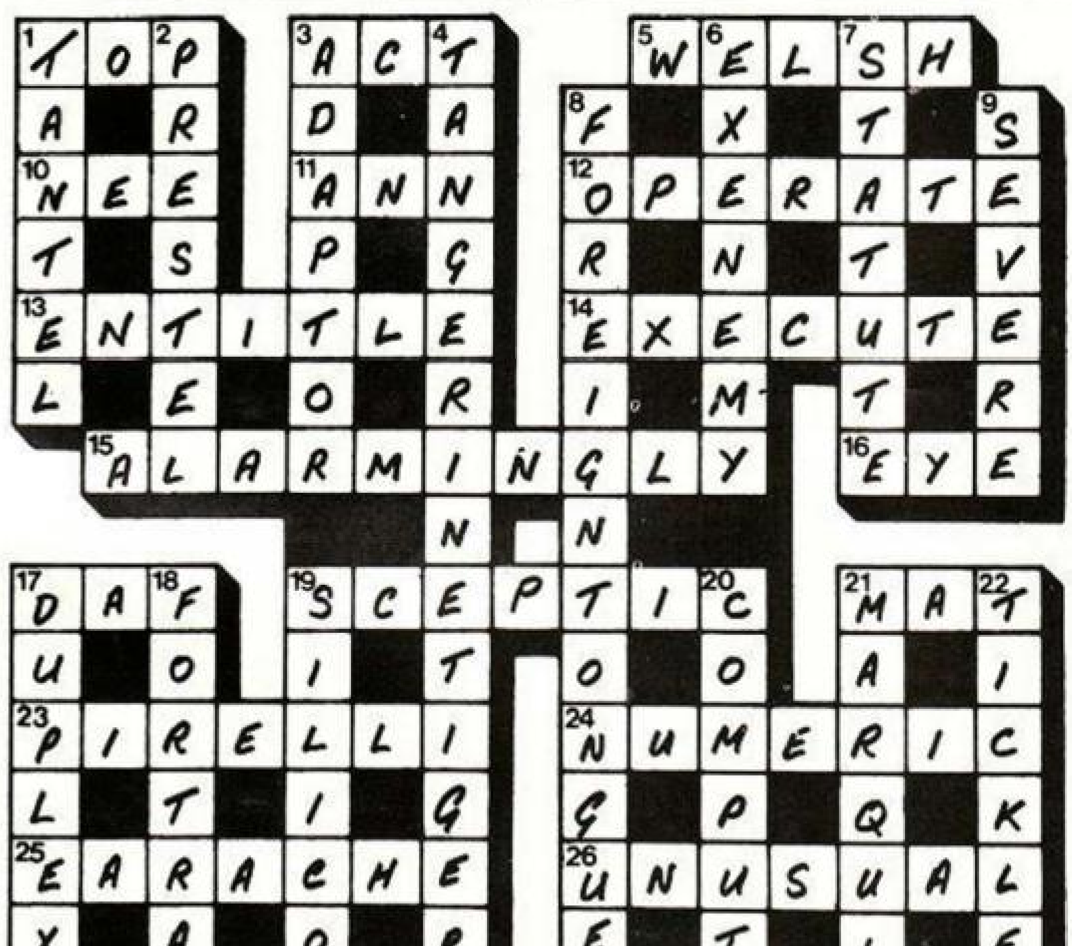
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The Orc's Egg



November crossword solution

The Orc's Egg

BY ANTHONY ROBERTS

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Here is the cave map. All the passages are one way.

A £15 book token will be awarded to the first correct solution drawn from the competition bag. All entries must be at the *Your Computer* offices by the last working day in January. The name of the winner, the solution, and a competition report will be published in the March issue of *Your Computer.*

If you want to set a competition for Competition Corner, remember that the simplest solution should be calculable by a short program rather than by any other form of reckoning.

Competition reports

IN THE NOVEMBER Competition Corner puzzle, Trolls' Cave, you are working out a form of Zeller's Congruence, which gives the day of the week of January 1 for any year 1901-2099, at least. Saturday is day 7, Sunday day 1. The formula is

$$\left| \frac{5(YY+1)}{4} + 2 \right|_7$$

so, as you need to be carrying just one diamond as you enter the last cave, you must make your break on a Sunday.

The winner, picked out of a bag with hundreds of correct entries — you obviously all found it too easy — is Peter Evans of 15 Moorland Road, York, YO1 4HF. A £15 book token is on its way to him.

There was a large response to the November crossword competition for a Tantel Adaptor. Most of the solutions sent in were correct, and the ingenuity used in completing the sentence "The most important feature of Prestel is . . ." made the task of choosing a winner extremely difficult. After much deliberation, the adaptor was awarded to I Copestake of 23 Connaught Crescent, Brookwood, Woking, Surrey, GU24 0AN, for his "Prestel lets your fingers do the talking".

British Telecom, and Busby in particular, came in for a fair amount of stick. J Roberts of Hatfield, Hertfordshire summed up the feelings of many people with "to put you in touch with Busby (preferably by the neck!)". An excellent variation on this theme was provided by M Birkett of Hooton, Cheshire, with "two-way communication — now you can give Busby the baud". A Heinrichsons of Wokingham, Berkshire, noted "it's an educational way of increasing the phone bill".

T Brown of Nantwich, Cheshire, had firm views on the intelligence of the family "it is simple enough for the whole family to use it". Other entries worthy of mention include Graham Perry's "that it demonstrates the viability of a non-commuting society" and Jem Ward's "you view the form, then form your view". ■

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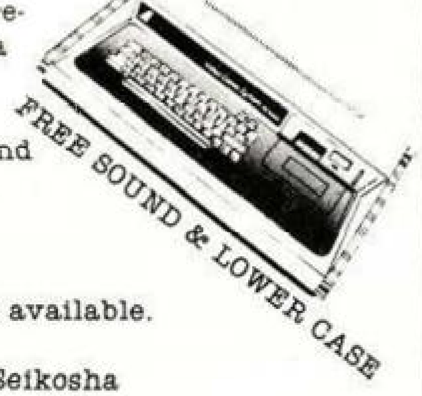
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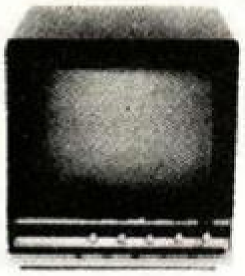
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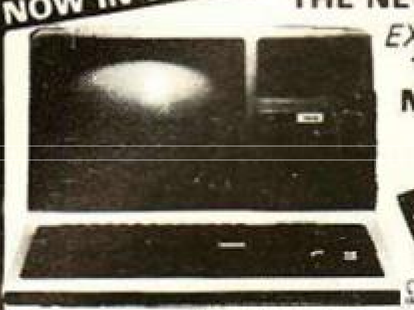
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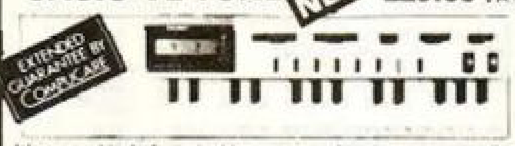
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Each cassette costs £3.95 (including VAT and p&p) and comes complete with full instructions.

Although primarily designed for the Sinclair ZX81, many of the cassettes are suitable for running on a Sinclair ZX80 – if fitted with a replacement 8K BASIC ROM.

Some of the more elaborate programs can be run only on a Sinclair ZX Personal Computer augmented by a 16K-byte add-on RAM pack.

This RAM pack and the replacement ROM are described below. And the description of each cassette makes it clear what hardware is required.

8K BASIC ROM

The 8K BASIC ROM used in the ZX81 is available to ZX80 owners as a drop-in replacement chip. With the exception of animated graphics, all the advanced features of the ZX81 are now available on a ZX80 – including the ability to run much of the Sinclair ZX Software.

The ROM chip comes with a new keyboard template, which can be overlaid on the existing keyboard in minutes, and a new operating manual.

16K-BYTE RAM pack

The 16K-byte RAM pack provides 16-times more memory in one complete module. Compatible with the ZX81 *and* the ZX80, it can be used for program storage or as a database.

The RAM pack simply plugs into the existing expansion port on the rear of a Sinclair ZX Personal Computer.



Cassette 1 – Games

For ZX81 (and ZX80 with 8K BASIC ROM)

ORBIT – your space craft's mission is to pick up a very valuable cargo that's in orbit around a star.

SNIPER – you're surrounded by 40 of the enemy. How quickly can you spot and shoot them when they appear?

METEORS – your starship is cruising through space when you meet a meteor storm. How long can you dodge the deadly danger?

LIFE – J. H. Conway's 'Game of Life' has achieved tremendous popularity in the computing world. Study the life, death and evolution patterns of cells.

WOLFPACK – your naval destroyer is on a submarine hunt. The depth charges are armed, but must be fired with precision.

GOLF – what's your handicap? It's a tricky course but you control the strength of your shots.

Cassette 2 – Junior Education: 7-11-year-olds

For ZX81 with 16K RAM pack

CRASH – simple addition – with the added attraction of a car crash if you get it wrong.

MULTIPLY – long multiplication with five levels of difficulty. If the answer's wrong – the solution is explained.

TRAIN – multiplication tests against the computer. The winner's train reaches the station first.

FRACTIONS – fractions explained at three levels of difficulty. A ten-question test completes the program.

ADDSUB – addition and subtraction with three levels of difficulty. Again, wrong answers are followed by an explanation.

DIVISION – with five levels of difficulty. Mistakes are explained graphically, and a running score is displayed.

SPELLING – up to 500 words over five levels of difficulty. You can even change the words yourself.

Cassette 3 – Business and Household

For ZX81 (and ZX80 with 8K BASIC ROM) with 16K RAM pack

TELEPHONE – set up your own computerised telephone directory and address book. Changes, additions and deletions of up to 50 entries are easy.

NOTE PAD – a powerful, easy-to-run system for storing and retrieving everyday information. Use it as a diary, a catalogue, a reminder system, or a directory.

BANK ACCOUNT – a sophisticated financial recording system with comprehensive documentation. Use it at home to keep track of 'where the money goes,' and at work for expenses, departmental budgets, etc.

Cassette 4 – Games

For ZX81 (and ZX80 with 8K BASIC ROM) and 16K RAM pack

LUNAR LANDING – bring the lunar module down from orbit to a soft landing. You control attitude and orbital direction – but watch the fuel gauge! The screen displays your flight status – digitally and graphically.

TWENTYONE – a dice version of Blackjack.

COMBAT – you're on a suicide space mission. You have only 12 missiles but the aliens have unlimited strength. Can you take 12 of them with you?

SUBSTRIKE – on patrol, your frigate detects a pack of 10 enemy subs. Can you depth-charge them before they torpedo you?

CODEBREAKER – the computer thinks of a 4-digit number which you have to guess in up to 10 tries. The logical approach is best!

MAYDAY – in answer to a distress call, you've narrowed down the search area to 343 cubic kilometers of deep space. Can you find the astronaut before his life-support system fails in 10 hours time?

Cassette 5 – Junior Education: 9-11-year-olds

For ZX81 (and ZX80 with 8K BASIC ROM)

MATHS – tests arithmetic with three levels of difficulty, and gives your score out of 10.

BALANCE – tests understanding of levers/fulcrum theory with a series of graphic examples.

VOLUMES – 'yes' or 'no' answers from the computer to a series of cube volume calculations.

AVERAGES – what's the average height of your class? The average shoe size of your family? The average pocket money of your friends? The computer plots a bar chart, and distinguishes MEAN from MEDIAN.

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